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DEPARTMENT OF THE ARMY

FLEET MARINE FORCE MANUAL

FM 3-12

FM FM 11-5

Ch 1,2

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OPERATIONAL ASPECTS OF RADIOLOGICAL DEFENSE

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DEPARTMENTS OF THE ARMY AND THE NAVY

AUGUST 1968

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Field Manual

Operational Aspects of Radiological Defense

Justification STANAG 2957 (NBC) (Edition 1) - Systeme International (SI) Units For Combat Dosimetry has now been ratified and changes the basic unit for combat dosimetry from the rad to the centigray (cGy). The STANAG states that from ratification until 1 January 1986 all NATO documents will reflect the new unit "centigray" or "cGy" followed by "rad" in brackets. After 1 January 1986 only the new unit will be used. FM 3-12 is one of three doctrinal publications required to implement this STANAG.

Expiration. This interim change expires 2 years from date of publication and will be destroyed at that time unless sooner rescinded or superseded by a permanent change.

1. FM 3-12, 21 August 1968, is changed as follows:

Page 1-2. Paragraph 1-3a.(5) is superceded as follows:

(5) Centigray (Rad). Unit of measurement of the absorbed dose of ionizing radiation. It represents the absorption of 100 ergs of nuclear (or ionizing) radiation per gram of absorbing material or tissue.

NOTE. For scientific and technical reasons, nuclear radiations are measured in a variety of units, to include the "roentgen" (r) "roentgen equivalent physical" (rep), "radiation absorbed dose" (rad), and "centigray" (cGy). For practical military use, all types of radiation are measured in centigray. This unit of measurement is used interchangeably with, and in lieu of, other units previously mentioned. For example:

1 rad = 1 cGy (centigray)
1 mrad = 0.001 cGy or 10 uGy (microgray)
1 rad/h = 1 cGy/h (centigray per hour)
1 mrad/h = 0.001 cGy/h or 10 uGy/h (microgray per hour)

All pages. The terms rad, mrad, rad/h and mrad/h are used throughout this manual. In all instances where they currently appear, the appropriate abbreviation from the example above should be placed in parenthesis immediately following the existing units. For example:

300 rad (cGy)
300 rad/h (cGy/h)
300 mrad (.3 cGy)
300 mrad/h (.3 cGy/h)

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2. Post these changes per DA PAM 310-13.

3. File this interim change to front of the publication.

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By Order of the Secretary of the Army:

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DEPARTMENTS OF THE ARMY

AND THE NAVY

WASHINGTON, D.C., *21 August 1968*

OPERATIONAL ASPECTS OF RADIOLOGICAL DEFENSE

		Paragraph	Page
CHAPTER 1.	INTRODUCTION		
Section I.	General	1–1—1–3	1–1
II.	Background knowledge	1–4—1–8	1–2
III.	Radiological intelligence	1–9—1–12	1–4.1
★CHAPTER 2.	NUCLEAR BURST DATA (NATO STANAG 2103)		
Section I.	Nuclear burst reporting	2–1—2–3	2–1
II.	Nuclear burst data collection	2–4—2–6	2–2
III.	Techniques for determining nuclear burst report data	2–7—2–13	2–4
★CHAPTER 3.	RADIOLOGICAL MONITORING (NATO STANAG 2103)		
Section I.	Introduction	3–1, 3–2	3–1
II.	Area monitoring	3–3—3–9	3–1
III.	Reporting and recording	3–10—3–15	3–4
IV.	Monitoring of personnel, food, water, and materiel	3–16—3–20	3–7
★CHAPTER 4.	RADIOLOGICAL SURVEY (NATO STANAG 2112)		
Section I.	Introduction	4–1—4–6	4–1
II.	Aerial radiological survey	4–7—4–15	4–2
III.	Ground radiological survey	4–16—4–23	4–10
IV.	Personnel and equipment requirements	4–24—4–26	4–13
★CHAPTER 5.	OPERATIONAL ASPECTS OF RESIDUAL RADIATION (NATO STANAG 2002)		
Section I.	Fallout	5–1—5–7	5–1
II.	Nonstandard decay of fallout	5–8, 5–9	5–10
III.	Induced radiation	5–10—5–16	5–14
IV.	Marking of contaminated areas	5–17—5–20	5–21
★CHAPTER 6.	RADIATION EXPOSURE GUIDANCE (NATO STANAG 2083)	6–1—6–11	6–1
★7.	RADIOLOGICAL OPERATIONS OF A TACTICAL OPERATIONS CENTER (NATO STANAGs 2103, 2104, and 2112)		
Section I.	Introduction	7–1—7–3	7–1
II.	Concept of operations	7–4—7–9	7–3
III.	Planning	7–10—7–15	7–6
IV.	Calculation procedures	7–16—7–22	7–9
V.	Plotting radiological contamination data	7–23—7–30	7–17
VI.	Presentation and dissemination of radiological contamination intelligence	7–31—7–34	7–20

* This manual supersedes FM 3–12, 31 January 1963, including C 1, 19 March 1964.

		Paragraph	Page
APPENDIX	A. REFERENCES		A–1
	B. SAMPLE APPENDIX TO CBR ANNEX OF AN INFANTRY DIVISION SOP		B–1
	★C. REPORTING NUCLEAR DETONATIONS AND RADIOACTIVE FALLOUT (NATO STANAG 2103)		C–1
	D. RECOMMENDED ARMY UNITS FOR NUCLEAR BURST DATA COLLECTION AND REPORTING		D–1
	E. DESCRIPTION OF NUCLEAR DETONATION DATA REPORTING SYSTEM FOR USMC USERS		E–1
	F. OPTIMUM TIME FOR EXIT OF FALLOUT AREAS		F–1
	G. OVERLAPPING FALLOUT PATTERNS		G–1
	H. CONVERSION SCALE		H–1
	★I. Rescinded		
INDEX			Index 1

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Purpose and Scope

This manual provides guidance for the collection and processing of nuclear burst and radiological contamination information and the use of radiological contamination intelligence at all levels of command for the field forces.

a. It provides doctrine, procedures, and techniques for nuclear burst reporting, radiological monitoring, radiological survey, processing radiological contamination information, residual radiation calculations, and radiation exposure and dosimetry considerations; it also describes the communications channels for the flow of unit radiation exposure status information.

b. It provides guidance for the radiological operations of a tactical operations center (TOC) of the division or comparable operations center or control center of other commands.

★*c.* The material presented in this manual is applicable to nuclear warfare and for use by CONUS armies and similar commands. The North American Air Defense Command uses NORAD Manual 55-19, Volume VIII.

1-1.1. U.S. Marine Corps Organization and Terminology

Marine Corps users of this manual substitute appropriate command echelons/elements, command post agency and terms as required by existing differences in tables of organization and terminology. For example, substitute regiment for brigade; fire support coordination center (FSCC) for fire support element (FSE); operations center for tactical operations center (TOC); nuclear, biological, and chemical (NBC) section for chemical, biological, and radiological element (CBRE); NBC teams for CBR teams; and NBC for CBR.

a. Information of an interim system for reporting nuclear detonation data by the US Marine Corps is contained in appendix E. This system is used for reporting parameters of nuclear detonations.

b. The techniques for reporting radiological fallout and contamination given in this manual are applicable to the Marine Corps.

1-1.2. International Standardization Agreements

This manual is in consonance with the following International Standardization Agreements, which are identified by type of agreement and number at the beginning of each appropriate chapter or appendix in the manual:

Title	*NATO STANAG*	*CENTO STANAG*	*SEATO SEASTAG*	*AECA SOLOG*
Marking of Contaminated or Dangerous Land Areas	2002	2002	2002	----
Radiological Hazards	2083	----	2083	----
Reporting Nuclear Detonations, Radioactive Fallout, and Biological and Chemical Attacks	2103	----	----	123
Friendly Nuclear Strike Warning to Armed Forces Operating on Land	2104	2104	----	130
Radiological Survey	2112	----	2112	----

1–2. User Comments

Users of this manual are encouraged to submit recommended changes and comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation.

a. US Army. User comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commanding Officer, U.S. Army Combat Developments Command CBR Agency, Fort McClellan, Alabama 36201.

b. US Marine Corps. User comments should be forwarded direct to the Commanding General, Marine Corps Development and Education Command (ATTN: Director, Development Center), Quantico, Virginia 22134.

1–3. Terms and Symbols

a. Explanation of Terms. Terms in this manual are used in accordance with JCS Pub 1 and AR 310–25. The following additional explanations are furnished:

(1) *Entry time.* The time, measured from the time of burst, at which personnel enter a radiation field to perform an action. In general, entry time is the time at which personnel exposure starts.

(2) *Induced radiation.* Radiation near ground zero resulting from the capture of neutrons by various substances. This will be found primarily in the soil but may also be present in other objects.

(3) *Militarily significant contamination.* Radioactive contamination capable of inflicting radiation doses to personnel which may result in a reduction in their combat effectiveness.

(4) *Operation exposure guide.* The maximum amount of nuclear radiation to which troops may be exposed, as determined by the commander, while performing a particular mission or missions.

(5) *Rad.* Unit of measurement of the absorbed dose of ionizing radiation. It represents absorption of 100 ergs of nuclear (or ionizing) radiation per gram of absorbing material or tissue.

Note. For scientific and technical reasons, nuclear radiations are measured in a variety of units, to include the "roentgen" (r), "roentgen equivalent physical" (rep), and "rad." For practical military use, all types of radiation are measured in rad. This unit of measurement is used interchangeably with, and in lieu of, other units previously mentioned (FM 101–31–1/FMFM 11–4).

(6) *Radiation dose.* The total amount of ionizing radiation absorbed by tissue or any other absorbing material; commonly measured in rad.

(7) *Radiation dose rate.* The radiation dose absorbed per unit of time; commonly measured in rad per hour.

★(8) *Radiological agent.* Any of a family of radioactive substances that produce casualties by emitting radiation. As used in this manual, radiological agents refer to contamination other than fallout or induced radiation.

(9) *Stay time.* The period during which personnel remain within a particular area of contamination or radiation hazard.

(10) *Turn-back-dose.* A radiation dose, determined by command decision prior to a survey, at which surveying personnel will turn back to avoid exceeding the operation exposure guide.

(11) *Turn-back dose rate.* A radiation dose rate, determined by command decision prior to a survey, at which surveying personnel will turn back to avoid undue exposure hazard.

b. Terms and Symbols (as used in this manual).

Symbol	*Term*
CF	Correlation factor
CRF	Correction factor
D	Total dose
D_c	Calculated dose
D_t	True dose
D_{tb}	Turn-back dose
GZ	Ground zero
ID	Inside dose rate; inside dose
n	Decay exponent
NBC	Nuclear, Biological, Chemical
NBC 1	Report used by observing unit, giving initial and subsequent data of a nuclear attack

Symbol	Term
NBC 2	Report used for passing evaluated data of a nuclear attack
NBC 3	Report used for immediate warning of expected contamination
NBC 4	Report used for radiation dose-rate measurements
NBC 5	Report used for locating areas of contamination
NF	Normalizing factor
OCRF	Overall correction factor
★OD	Outside does rate; outside dose
R_1	Dose rate at, or referenced to, 1 hour after burst (H + 1)
R_{avg}	Average dose rate
R_{max}	Maximum dose rate
★RS-0	Radiation Status—0
RS-1	Radiation Status—1
RS-2	Radiation Status—2
RS-3	Radiation Status—3
R_t	Dose rate at a time after burst, other than H + 1
R_{tb}	Turn-back dose rate
R_{T_e}	Dose rate at time of entry
STANAG	Standardization Agreement
★T	Time
T_e	Time of entry into a contaminated area
TF'	Transmission factor
T_s	Time of stay (stay time) in a contaminated area
T_x	Time of exit from a contaminated area
UTM	Universal transverse mercator (grid coordinates)

Section II. BACKGROUND KNOWLEDGE

1–4. General

Under the threat of or actual conditions of nuclear warfare, units in the field must continuously evaluate the impact that enemy use of nuclear weapons has on the conduct of operations and be prepared for contingency action to reduce the disruption caused by a nuclear attack. Fallout may be employed to blanket areas of poorly defined targets, create obstacles, canalize movement, disrupt conduct of operations, and force relocation of support installations. Casualty-producing levels of fallout can extend to greater distances and cover greater areas than most other nuclear weapon effects and can, therefore, influence actions on the battlefield for a considerable period of time. Knowledge of and understanding by commanders and individuals at all levels of the radiological contamination aspects discussed in this manual will permit the commander to determine more accurately the advantages and disadvantages of each course of action open to him in the execution of assigned missions.

1–5. The Contaminated Area

The radioactive material in a contaminated area is assumed to be spread evenly over the ground. An individual standing in a level portion of a contaminated area will thus be receiving radiation from all directions. However, because of absorption by the air and other factors, essentially all radiation the individual receives comes from a circular area 200 meters in radius around his location. About half the radiation the individual receives comes from a circular area 10 meters in radius around his location.

a. The Fallout Area. Fallout areas will be the largest of the contaminated areas produced on the battlefield. One particularly important aspect of fallout is that the direction of fallout from ground zero is based upon winds aloft as well as upon surface winds. Thus, the actual location of fallout can differ appreciably from that which might be expected from the direction of surface winds.

(1) *Automatic fallout response.* The rapid onset of fallout, especially from small yields, within a few kilometers of ground zero of a surface burst requires quick adoption of protective measures. The time after burst before onset of fallout near ground zero will vary, depending on the yield of the nuclear detonation, weather conditions, and type of terrain. Normally, use of shelter will be automatic whenever nuclear bursts are observed, since these

bursts should be assumed to be fallout producing until monitoring and the passage of time prove otherwise. During the period of uncertainty, precautionary measures consistent with the mission are instituted. See FM 21–40 and FM 21–41 for information on appropriate precautionary measures.

(2) *Physical recognition of fallout.* Fallout particles are often visible during hours of daylight. The arrival and settling of dustlike particles after a nuclear burst occurs should be assumed to indicate the onset of fallout unless monitoring shows no radiation in the area.

★*b. The Neutron-Induced Area.* The neutron-induced area is small by comparison with the fallout area produced by the same yield nuclear weapon. It is often contained within the area of great destruction and collateral obstacles (tree blowdown, rubble, and fire). Frequently there will be no need to enter the area. However, if friendly troops are required to pass through ground zero or occupy positions in the immediate vicinity of ground zero, induced radiation may be operationally significant (para 5–12). Total dose predictions are based on actual dose rates obtained from radiological surveys or from monitoring reports.

1–6. Decay of Contamination

The dose rate at any location within a contaminated area does not remain constant but decreases with time. Thus, in time, a radiation hazard will be no military significance. The rate at which this decay takes place also varies with time, generally becoming slower as time passes. The decay rate for contamination in an area depends upon many factors and generally cannot be accurately determined until several series of dose-rate readings are available for specific locations within the contaminated area. Standard decay conditions (para 5–2*a* for fallout and para 5–13*a* for induced contamination) are therefore assumed by all units until actual conditions are determined or until higher headquarters directs otherwise.

1–7. Radiac Instruments

Radiac instruments measure gamma radiation without regard to its source. The doses or dose rates of radiation measured may represent gamma radiation from fallout, radiological agents, neutron-induced radioactivity, natural background radiation, or a combination of these. The radioactive materials from these contamination sources emit alpha, beta, and gamma radiation. However, only the gamma hazard will be significant if the proper protective measures are taken by exposed personnel (FM 21–41).

1–8. Transmission Factors

a. Ground Dose Rate. The ground (outside) dose rate is the unshielded dose rate measured 1 meter above ground level (about waist high). This dose rate approximates the average whole body dose rate a man would receive if he were standing in the open in the contaminated area at the location of the measurement. Ground dose rates are the basic reference used to determine the magnitude of a contamination hazard. All dose rates mentioned in radiological intelligence are ground dose rates unless otherwise specified. Thus, all dose-rate information obtained under conditions that would modify the ground dose rate must be converted to ground dose rates for radiological intelligence purposes.

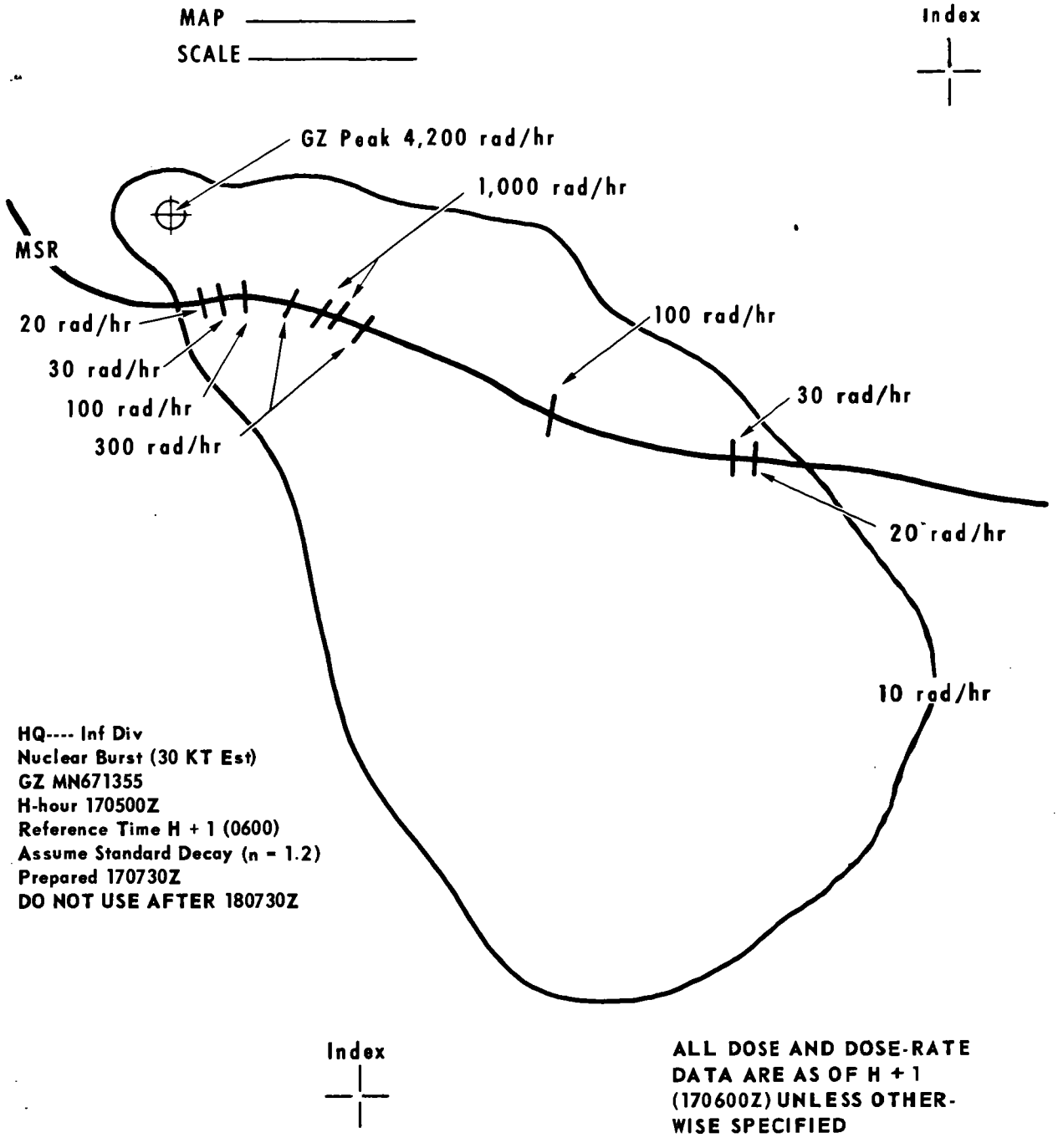
b. Factors Affecting Determinations of Ground Dose Rates. Because some radiation is shielded out, the dose rate inside a vehicle or shelter is lower than the ground dose rate at that location. The degree of shielding depends on the type of vehicle or the construction of the shelter. Dose rates measured in an aircraft flying over a contaminated area are lower than the corresponding ground dose rates because of the shielding effect of the air and the aircraft.

c. Transmission Factors. A transmission factor (TF) is a measure of the degree of shielding afforded by a structure, vehicle, fortification, or a set of specified shielding conditions. The transmission factor is that fraction of the outside (ground) dose or dose rate which is received inside the enclosure which provides the shielding (para 5–5).

Section III. RADIOLOGICAL INTELLIGENCE

1–9. Types of Radiological Intelligence

To aid the commander and his staff in evaluating the effects of radiological contamination on the mission of the unit, the following forms of intelligence, listed in order of preparation, will be disseminated:



★*Figure 1–1. Simplified radiological contamination overlay.*

a. Fallout Prediction. A fallout prediction indicates a general area in which militarily significant fallout is expected to occur. The predicted area (zones I, I–A, and II) of fallout is larger than the actual area of the ground that will be covered by this fallout. This represents an area of potential hazard. Because of uncertainties of weather and nuclear burst input data, the precise location where fallout within the area may occur cannot be reliably predicted, but must be ascertained by monitoring and survey after fallout has arrived. The area has, therefore, been developed so that there is a reasonably high assurance that the expected fallout will not occur outside of it. The occasions that require the preparation of fallout predictions are listed below. (For detailed discussion and illustration of fallout prediction, see TM 3–210.)

(1) For target analyses of friendly nuclear weapons when a surface burst is desired, when the weapon system does not provide a 99 percent assurance of no militarily significant fallout, or when a contact surface burst backup fuzing is to be used.

(2) For a nuclear burst when postburst information indicates the probable or actual occurrence of fallout.

b. Radiological Contamination Overlay. Radiological contamination overlays indicate the contamination in areas of interest. The overlay is based on measured dose rates and outlines the known areas of contamination. It attempts to provide sufficient data about dose rates existing within the contaminated area and, when used in conjunction with unit radiation exposure history information, permits a determination of the expected effects of the hazard on operations conducted in the area. Radiological contamination overlays may vary from the simplified type to the detailed type. When time or operational requirements limit the flow of information in areas not controlled by friendly troops, simplified contamination overlays may be the only type of radiological contamination overlay available to the commander. When time and operational limitations are less severe, the detailed contamination overlay is prepared. Brief descriptions and illustrations of both contamination overlays follow:

(1) *Simplified radiological contamination overlay* (fig. 1–1). The simplified contamination overlay shows the general limits of the contamination (7–8*c*(1)) and the minimum dose-rate information necessary to satisfy command requirements.

(2) *Detailed radiological contamination overlay* (fig. 1–2). The detailed contamination overlay defines the limits of the contamination more precisely than does the simplified overlay and shows dose-rate contours. It may include such refinements as dose calculations for critical crossing routes or points and lines indicating the time of completion of fallout at certain locations.

1–10. Forms of Radiological Contamination Information

The following information must be available to develop radiological intelligence:

a. Basic Prediction Data. The basic data required for fallout predictions consist of upper air wind data and nuclear burst data. The collection of nuclear burst data is described in chapter 2. Procedures for the utilization of upper air wind data are covered in TM 3–210.

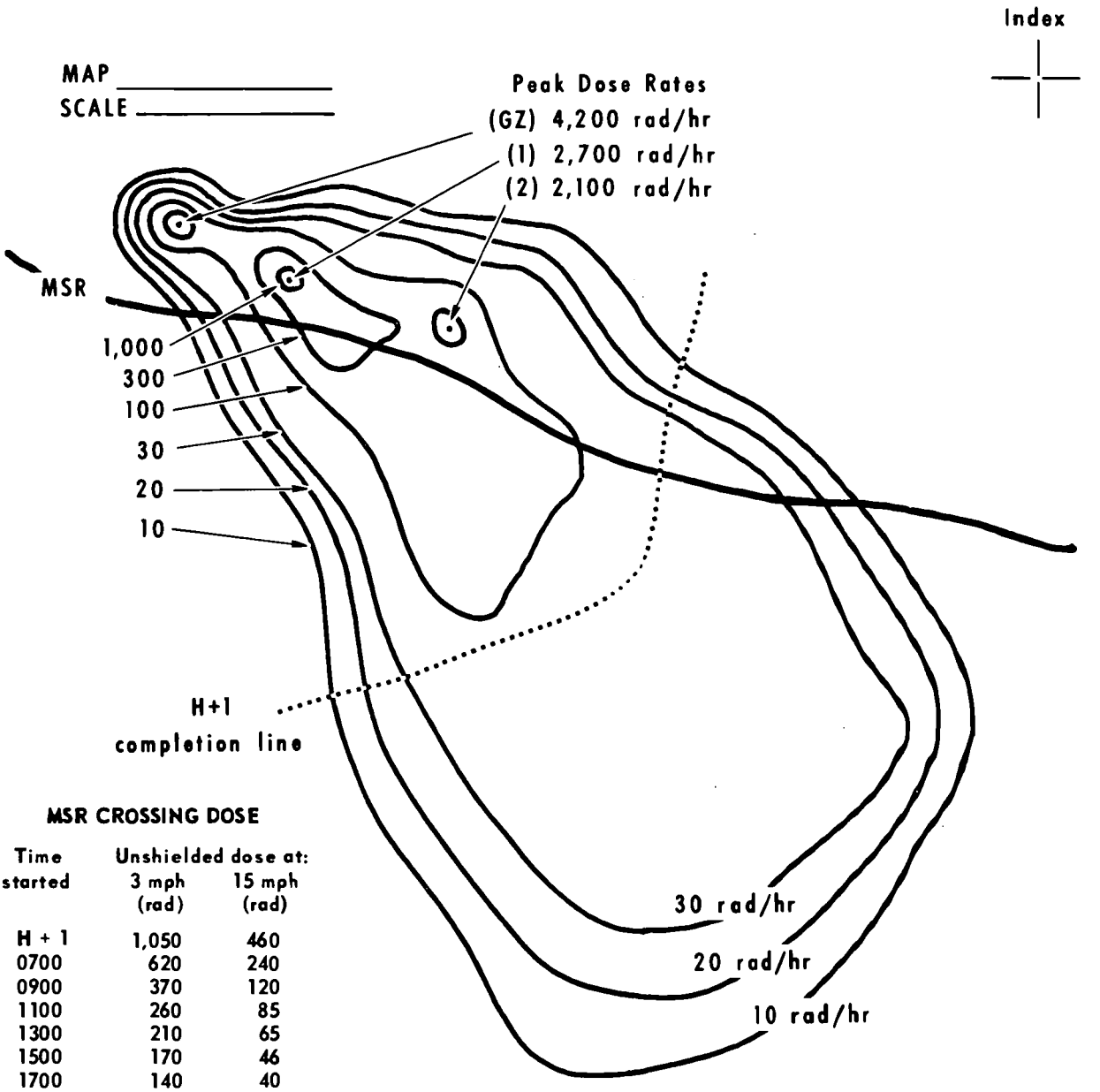
b. Radiological Monitoring Data. Radiological monitoring data (chap 3) provide part of the information necessary for the preparation of contamination overlays.

c. Simplified Radiological Survey Data. Simplified radiological survey data (chap 4) provide, in the least possible time and in areas where monitoring information is incomplete, the minimum essential information to prepare the simplified radiological contamination overlay.

d. Detailed Radiological Survey Data. Detailed radiological survey data (chap 4) complete the data necessary for preparation of the detailed contamination overlay.

1–11. Command and Staff Responsibilities for the Collection Effort

The radiological information is collected by using organic personnel and equipment. Com-



MSR CROSSING DOSE

Time started	Unshielded dose at: 3 mph (rad)	15 mph (rad)
H + 1	1,050	460
0700	620	240
0900	370	120
1100	260	85
1300	210	65
1500	170	46
1700	140	40

HQ ---- Inf Div
Nuclear Burst (30 KT)
GZ MN671355
H-hour 170500Z
Reference Time H + 1 (0600)
Standard Decay (n = 1.2)
Prepared 171000Z
DO NOT USE AFTER 191000Z

All fallout completed by H + 2 hours (0700)

ALL DOSE AND DOSE-RATE DATA ARE AS OF H + 1 (170600Z) UNLESS OTHERWISE SPECIFIED

★*Figure 1-2. Detailed radiological contamination overlay.*

mand and staff actions by organizations, as indicated below, are necessary to insure an adequate collection effort.

a. Company/Troop/Battery Units. Radiological monitors and radiological survey parties from company/troop/battery CBR teams obtain the basic contamination information required by the tactical operations center of the division and other commands to prepare contamination charts. A CBR team is a unit team appointed by the unit commander. This team includes table of organization and equipment (TOE) personnel who are used for CBR unit defense and perform the CBR functions as an additional duty. (See AR 220–58 for authority for organizing CBR teams an FM 21–40 for organization and functions of unit CBR teams. When the unit TOE does not provide sufficient equipment to meet this requirement, CTA 50–914 may be used as the authority for U.S. Army units to requisition the minimum essential radiac and detection equipment required.) The company/troop/battery commander appoints the following:

(1) A minimum of two monitors for each survey meter authorized. These monitors receive specialized school or unit training in ground and aerial survey duties.

(2) One ground survey party (4–1) for each survey meter authorized. In addition to the monitors, the survey party will include drivers, radio operators, and security personnel as required.

(3) Selected individuals trained to satisfy the company's/troop's/battery's own requirements for nuclear burst estimation (chap 2). Nuclear burst data obtained by these observers are used by the company/troop/battery commander for estimates of the situation and for simplified fallout predictions with the M5A1 predictor (TM 3–210). *These data are not reported to higher headquarters unless specifically requested.*

b. Brigade, Battalion, and Similar Organizations. Information from the collecting units (*a* above) flows to the evaluating commands (*c* below). The S2 is responsible for the radiological intelligence effort at brigade, battalion, and similar organizations, and the staff functions parallel staff functions at division headquarters.

(1) Radiological survey and monitoring data are the principal items of information that will flow through these headquarters. All contact dose-rate and peak dose-rate monitoring reports are forwarded with minimum screening by intermediate headquarters. Other monitoring reports are consolidated, and the minimum data required to illustrate the typical contamination status in the area of responsibility are forwarded (para 3–11 and 3–12). To satisfy responsibilities for radiological survey, each headquarters establishes and trains at least one radiological survey control party (chap 4).

(2) In addition to the responsibilities discussed above, selected field artillery and air defense artillery battalion headquarters units, and other units as required, use organic angle-measuring devices and communication equipment to observe and report nuclear burst data (chap 2). Observers' reports include the raw data from which are determined ground zero, yield, type, and time of nuclear burst. Initial nuclear burst reports normally have a FLASH precedence and are forwarded to the evaluating commands (*c* below) without being delayed at intermediate headquarters.

★*c. Division, Corps, and Field Army.* Staff responsibilities for developing the intelligence described in paragraphs 1–9 and 1–10 are delineated in FM 101–5. In major commands within a field army, the radiological intelligence responsibility is part of the CBR mission of the tactical operations center (TOC) and is normally accomplished by the TOC's chemical, biological, and radiological element (CBRE). TOE 3–500 (team JA or JB) and chapter 7 establish the mission, responsibilities, and operational procedures of the CBRE in the radiological intelligence efforts. See FM 3–1 for organization of the CBRE within the TOC.

d. CONUS Army, Combat Service Support, and Similar Commands. CONUS Army, combat service support, and other major commands having area responsibilities organize parallel to

equivalent tactical commands in order to satisfy their radiological intelligence requirements. Personnel and equipment necessary for these requirements are drawn from within established TOE, table of distribution (TD), or table of allowances (TA) authorizations.

e. Tactical Operations Center or Equivalent Organization. At division and higher headquarters, the CBRE of the TOC or equivalent organization that performs the radiological intelligence functions must maintain a record of all radiological contamination and nuclear bursts (friendly and enemy) that have occurred in areas of responsibility and interest. This record provides the commander and his staff with a clearing point for queries concerning details of radiological contamination and nuclear bursts. Information is also disseminated as directed by G2 and G3.

1-12. Use of the Types of Intelligence

As a type of radiological contamination intelligence, fallout predictions are only estimates of areas where fallout is likely to occur and are used at all echelons for determining what impact the contamination hazard may have on the conduct of operations if fallout results. Fallout predictions are also used for delineating areas to be surveyed. Radiological contamination overlays, however, depict actual contamination situations. Their use involves calculation of probable total doses of radiation absorbed or to be absorbed by personnel operating in the contaminated area, estimation of resulting casualties, and estimation of effect of casualties on accomplishment of the mission. Procedures for these dose calculations and casualty estimates are contained in chapter 5. Use of each of the types of radiological intelligence is discussed below.

a. Prestrike and poststrike fallout predictions provide a reasonable assurance that no significant hazard will occur outside the predicted area and that if fallout results, a significant hazard will occur somewhere inside the area. These predictions will not indicate the exact location or magnitude of the hazard within the predicted area but provide the commander and staff with information from which to warn units of a possible hazard. With this information, the commander can consider the unit radiation history and impact of further exposure on unit combat effectiveness and mission accomplishment and make plans to minimize or avoid undesirable effects.

b. Prestrike fallout predictions are used by the commander and staff in their estimates and planning actions to prepare for contingency actions that will reduce the disruption caused by the fallout hazard should it occur.

c. Poststrike fallout predictions warn the commander and staff of a hazard that is developing and may be used *to plan* the movement of units to alternate positions. Operational moves will normally not be executed based upon the poststrike prediction alone and will, where possible, be delayed until monitoring or survey data are available (app F). The poststrike prediction may also be used to plan the detailed collection effort for obtaining monitoring data to prepare the radiological contamination overlay as prescribed by local standing operating procedure (SOP).

d. Detailed radiological contamination overlays provide the commander and staff with intelligence sufficiently detailed and reliable to allow estimation of the impact which the contamination hazard already present may have on mission and operations being conducted, and to select courses of action that minimize or avoid the effects of the hazard.

e. An analysis of all enemy nuclear bursts that have occurred in the area of operations may provide an indication of the types and yields of nuclear weapons available in the enemy stockpile and the methods of delivery, as well as tactics of employment.

CHAPTER 2

NUCLEAR BURST DATA
(NATO STANAG 2103, ABCA SOLOG 123)

Section I. NUCLEAR BURST REPORTING

2-1. General

Nuclear burst data must be obtained and reported to provide information for determining the location of ground zero and for estimating yield.

★*a.* Normally, only those units specified in paragraph 2-4 will make the required measurements and report the data to higher headquarters. However, the techniques described in this chapter for obtaining nuclear burst information are generally applicable to any other unit that desires this information for preparing its own estimate of the situation or a simplified fallout prediction. A listing of units considered most suitable (from the standpoints of battlefield location and angle-measuring equipment) for nuclear burst data collection and schematic illustrations of envisioned nuclear burst data flow are contained in appendix D. They are included for information only, and will serve as a reference and an aid to commanders in reviewing their nuclear burst collection effort. A nuclear detonation data reporting system for the U.S. Marine Corps is described in appendix E.

b. It is unlikely that any one unit will be in a position to obtain all the information specified in the nuclear burst report format of paragraph 2-2*b*; however, units should strive to ascertain and report as much of the data as possible.

★*c.* The final location of fallout depends mainly on the heights from which the fallout particles start their descent and the wind structure between the ground and the various parts of the nuclear cloud when these particles are falling. The heights from which the particles start falling depend on the total yield of the fallout-producing nuclear burst, the size of the particles, and existing weather conditions. Thus, since the yield is determined from nuclear burst information, the reliability of the prediction depends to a great extent on the upper air wind data and the nuclear burst information available.

2-2. The Nuclear Burst Report (NBC 1)

★*a. Need.* The nuclear burst report provides information (or data from which the information can be derived) essential to commanders and staffs for estimates of the situation and for fallout prediction (para 2-7*a*).

★*b. Reporting.* Nuclear, Biological, and Chemical (NBC) report formats standardize the reporting of enemy nuclear, biological, and chemical attacks and conform to STANAG 2103 (app C). Only that part of STANAG 2103 which pertains to the use of the NBC 1 report is presented in this chapter. The techniques for determining nuclear burst report data are covered in section III. Using the format shown below, observers report nuclear burst data to a designated tactical operations center (TOC) by the most expeditious means available.

NBC 1. REPORT USED BY OBSERVING UNIT

Type of Report: NBC 1 (Nuclear)

A. Strike Serial Number (if known). (The strike serial number will be assigned by the CBRE at the operations center responsible for the area in which the strike occurs.)
B. Position of Observer (UTM or place).
C. Direction Measured Clockwise from Grid or Magnetic North (state which) of the Attack from Observer. (Report in degrees or mils, state which.)
D. Date and Time of Detonation (local or ZULU, state which). (If local time is used, transmit the letter of the local time zone, if known; transmit the word "local" if the time zone is unknown. See FM 101–10–1 for time-zone charts.)
E. Illumination Time (report in seconds).
F. Location of Attack (ground zero, actual or estimated, state which). (If the coordinates or the actual place of attack is reported, such as RJ34" or "Hill 301," omit the letter items B and C.)
G. Means of Delivery, if known.
H. Type of Burst (air, surface, or unknown—state which). (This letter item must be reported.)
J. Flash-to-Bang Time (seconds).
K. Crater Present or Absent and Diameter, if known (meters).
L. Nuclear Burst Angular Cloud Width. (Measure at 5 minutes after burst; report in mils or degrees, state which. Do not report if data are obtained more than 5 minutes after burst.)
M. Stabilized Cloud-Top Angle and/or Cloud-Bottom Angle (state which) or Cloud-Top Height and/or Cloud-Bottom Height (state which). (Measure at H + 10 minutes; report in mils, degrees, meters, or feet—state which.)

★*c. Special Instructions.* Follow these special instructions when reporting a nuclear burst.

(1) *Initial nuclear burst report.* Transmit all data except letter items L and M as soon as operationally possible after bang time in the initial nuclear burst report (para 2–3*a*).

(2) *Subsequent nuclear burst report.* Obtain additional data and submit a subsequent nuclear burst report (para 2–3*b*). Include the type of report and letter items D and H; include either letter items B and C or F ((*c*) below).

(*a*) Transmit letter item L immediately after measurement of the angular cloud width at 5 minutes after the burst. If data are not obtained at H + 5 minutes, do not report letter item L.

(*b*) Transmit letter item M immediately after measurement of the angle or height at H + 10 minutes if data for letter item L were not reported. Unless instructed otherwise, letter item M will be reported only when the angular cloud-width measurements (letter item L) were not reported.

(*c*) Transmit letter items B and C in this report if they were included in the initial report; or transmit letter item F if it was included in the initial report.

(3) *Exceptions.* In case data specified in (1) and (2) above cannot be obtained—

(*a*) Transmit only those letter items of the format for which data are available.

(*b*) Transmit letter item E only when other measured data are not available.

2–3. Example Nuclear Burst Reports

★The examples of nuclear burst reports shown below follow the format and special instructions in paragraph 2–2, as the data would be reported by an observer. The unit SOP should be followed.

★*a. Example of Initial Nuclear Burst Report.* The initial nuclear burst report normally is transmitted with a FLASH precedence. This example illustrates voice transmission. The observer's location is encoded for security reasons.

Example Initial Nuclear Burst Report

FLASH 090910 ROMEO
UNCLASSIFIED
FROM REDDOG TO AMIGO
NBC 1 NUCLEAR
BRAVO SHACKLE DELTA HOTEL BRAVO
UNSHACKLE
CHARLIE GRID 182 MILS
DELTA 090907 ROMEO
HOTEL SURFACE
JULIET 60
END OF MESSAGE

★*b. Example of Subsequent Nuclear Burst Report.* The subsequent nuclear burst report normally is transmitted with an IMMEDIATE precedence.

(1) This example illustrates the subsequent report by voice transmission with data for letter item L obtained at 5 minutes after the burst.

Example Subsequent Nuclear Burst Report (including letter item L)

IMMEDIATE 090913 ROMEO
UNCLASSIFIED
FROM REDDOG TO AMIGO
NBC 1 NUCLEAR
BRAVO SHACKLE DELTA HOTEL BRAVO
UNSHACKLE
CHARLIE GRID 182 MILS
DELTA 090907 ROMEO
HOTEL SURFACE
LIMA 280 MILS
END OF MESSAGE

(2) This example illustrates the subsequent report with letter item B in the clear and data for letter item M obtained at 10 minutes after the burst.

Example Subsequent Nuclear Burst Report (including letter item M)

IMMEDIATE 090918 ROMEO
UNCLASSIFIED
FROM REDDOG TO AMIGO
NBC 1 NUCLEAR
BRAVO ET 054066
CHARLIE GRID 182 MILS
DELTA 090907 ROMEO
HOTEL SURFACE
MIKE 550 MILS TOP
END OF MESSAGE

Section II. NUCLEAR BURST DATA COLLECTION

2–4. Responsibilities

Headquarters units of field artillery and air defense artillery battalions and air defense artillery batteries are generally the most suitable units for the collection and reporting of nuclear burst data. Normally, these units will be given this responsibility. At the discretion of appropriate commanders, other units (app D) may also be designated as collection and reporting agencies.

a. The recommended sequence for obtaining nuclear burst data is provided in paragraph 2–5. Initial nuclear burst reports normally have a FLASH precedence and are forwarded by the most expeditious means available through command, intelligence, or artillery channels to either the TOC or the area damage control center (ADCOC), as specified by local directive. The following organic optical equipment items, listed in order of preference, are used for nuclear burst surveillance:

(1) Aiming circle, M2.

(2) BC scopes, M65 or M43.

(3) Theodolites, T16 or T2.

(4) Pocket transit; compass, M2.

b. Listings of suggested primary and alternate collection units and typical communications channels are given in appendix D. US Marine Corps collecting and reporting procedures are given in appendix E.

2–5. Sequence of Events

★The most probable sequence of events and the recommended field procedures for the observer gathering nuclear burst data are outlined below.

★*a.* At the instant of the "blue-white flash," hit the ground, start the stopwatch (if available), and start counting slowly—1000 and one, 1000 and two, 1000 and three, and so on until the arrival of the shock wave or bang. Do not look at the fireball. Stay under cover if possible until the shock wave or bang has passed and debris has stopped falling. Make a mental note of the count on which the shock wave arrived (for example, 1000 and four), stop the stopwatch (if used), and continue counting to 1000 and five.

★*b.* After the shock wave (bang) has passed or the count of 1000 and five is reached (whichever is later), uncover the eyes, read the local time (wristwatch reading) to the nearest second, and then observe the developing cloud. If the bang is not heard in 5 minutes (that is, a count of 300), continue with other measurements.

★*c.* Record the count on which the shock wave arrived as letter item J (for example, 4 seconds), or record the stopwatch reading, if used. Record the local time reading made (*b* above) to the nearest minute as letter item D. If throwout (earth particles that have fallen

back and built up on the edge of the crater) can be observed or if a thick, dense stem has developed, report "SURFACE" as letter item H. If the stem is not connected to the mushroom part of the cloud, report "AIR." If in doubt or if determination definitely cannot be made, report "UNKNOWN" as letter item H. If throwout was observed, also enter YES as letter item K; otherwise leave blank.

Note. The reported local time is important to the resolution of burst data involving multiple nuclear bursts; hence, observers should synchronize their watches daily with official time whenever possible.

d. If visibility permits observation of ground zero (GZ), determine by map inspection the coordinates of GZ, and record them with the name of the place as letter item F.

e. If ground zero cannot be observed, measure the azimuth from observer location to the center of the stem or mushroom cloud. Enter this azimuth in mils or degrees, state which, as letter item C.

f. Complete letter item B and submit the initial nuclear burst report (NBC 1).

★*g.* Five minutes after detonation, measure the angular width of the mushroom cloud. Enter this width in degrees or mils, state which, as letter item L. If the angular cloud width is not obtained, measure the stabilized cloud dimensions 10 minutes after burst and enter as letter item M. Submit the subsequent nuclear burst report (NBC 1), including letter items B, C, D, and H (para 2–2*c*).

h. When the above measurements cannot be made (nighttime or when visibility is poor), the following measurements should be made.

(1) Hit the ground at the flash and estimate the duration of illumination as in *a* above; estimate the remainder of the flash-to-bang time. Enter data as letter items E and J.

(2) If possible, measure the azimuth to the stem or nuclear burst cloud center as soon as possible after the bang is heard. Enter data as letter item C.

(3) Complete letter items B, D, and H.

(4) Submit nuclear burst report (NBC 1).

2–6. Aerial Reconnaissance of Nuclear Bursts

All requests for aerial surveillance and reconnaissance missions are submitted by the CBRE of the TOC to the G2 Air. For friendly preplanned and on-call nuclear strikes, a preplanned request is submitted. For friendly target-of-opportunity, enemy and unidentified nuclear detonations, an immediate request is submitted. In both cases, inflight reports are made over prearranged communications channels to the CBRE of the TOC to expedite receipt of the information. Submission of requests for aerial surveillance and reconnaissance missions, and appropriate communications channels available for inflight reporting are covered in FM 30–20.

Section III. TECHNIQUES FOR DETERMINING NUCLEAR BURST REPORT DATA

2–7. Nuclear Burst Information

a. Requirements.

(1) *Estimates of the situation.* The essential nuclear burst information required for estimates of the situation is location of GZ, yield, time of burst, and type of burst.

(2) *Fallout predictions.* The essential nuclear burst information required for the preparation of either a detailed fallout prediction or a simplified fallout prediction is location of GZ, yield, and time of burst. Nuclear burst information used to prepare fallout predictions is derived from nuclear burst reports submitted by units observing the burst (para 2–4), aerial surveillance units, or from information obtained from the fire support element (FSE).

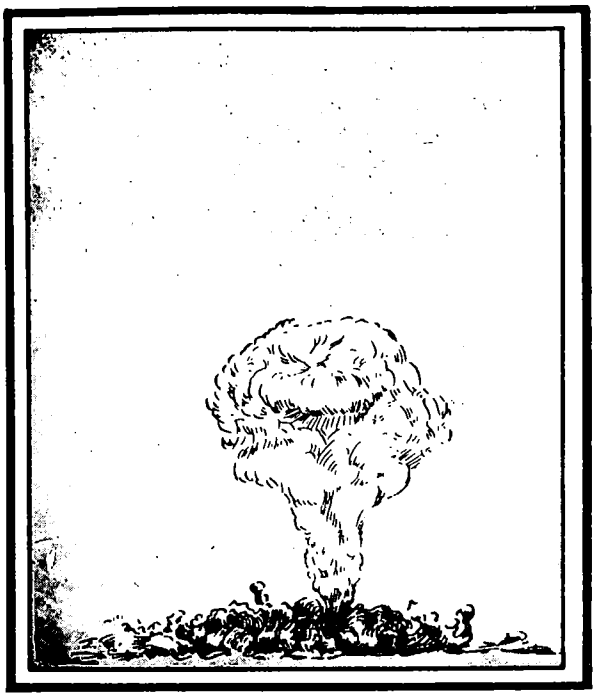
b. Special Nuclear Burst Information. The size of the predicted fallout area is dependent in part upon height of burst (HOB) and fission yield-total yield (FY/TY) ratio. The target analyst in the FSE can provide these two factors for fallout predictions of planned surface bursts. If a planned friendly airburst has inad-

vertently produced fallout, the FY/TY ratio can be obtained from the target analyst in the FSE. For enemy bursts, no means of estimating HOB and FY/TY ratio are available. Thus, for enemy bursts, no correction for these two factors is made in preparation of fallout predictions in the field army.

2–8. Miscellaneous Reportable Information

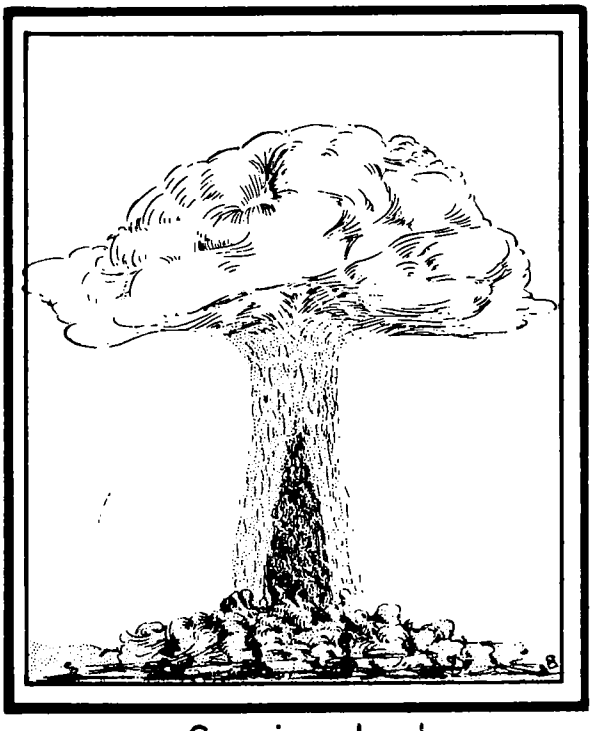
a. Development of nuclear clouds is divided into three stages for the purpose of yield estimation. The *fireball stage* exists from the instant of detonation until the generally spherical cloud of explosion products ceases to radiate a brilliant light. During this stage the fireball must not be observed because the very brilliant light is capable of causing permanent damage to the eyes. As the brilliant light fades into a dull reddish glow, the fireball stage transforms into the *nuclear burst cloud stage.* The nuclear burst cloud stage begins when the light of the fireball has faded to the point that the cloud from the explosion can be safely observed by the unprotected eye. At this time the nuclear burst cloud may be seen as either a spherical cloud (high airburst) or a mushroom-type cloud (low air or surface burst). (Relatively low yield nuclear surface bursts have clouds similar to those produced by surface bursts of conventional explosives.) Severe turbulence and rapid growth in height and width are characteristics of this stage of development. This nuclear burst cloud stage continues until the cloud ceases to grow in height (stabilizes in height) although the width may continue to increase. Height stabilization occurs from about 4 to 14 minutes after the explosion, depending upon the yield. When the cloud ceases to grow in height, the *stabilized cloud stage* begins and continues as long as the cloud is detectable. The orderly sequence of development of the cloud formation phases of a typical surface nuclear burst (fireball to nuclear burst cloud to stabilized cloud) is illustrated (by an artist's sketch) in figure 2–1.

b. Flash-to-bang time is the time interval in seconds between the "blue-white flash" of the detonation and the arrival of the sound of the explosion or the shock wave at the position of an observer. The sound of the explosion (bang) travels at an average velocity of 350 meters per second. The distance in meters from an observer to ground zero can be estimated by multiplying the flash-to-bang time in seconds by 350; this distance can be read in kilometers directly from the right scale of figure 2–4.

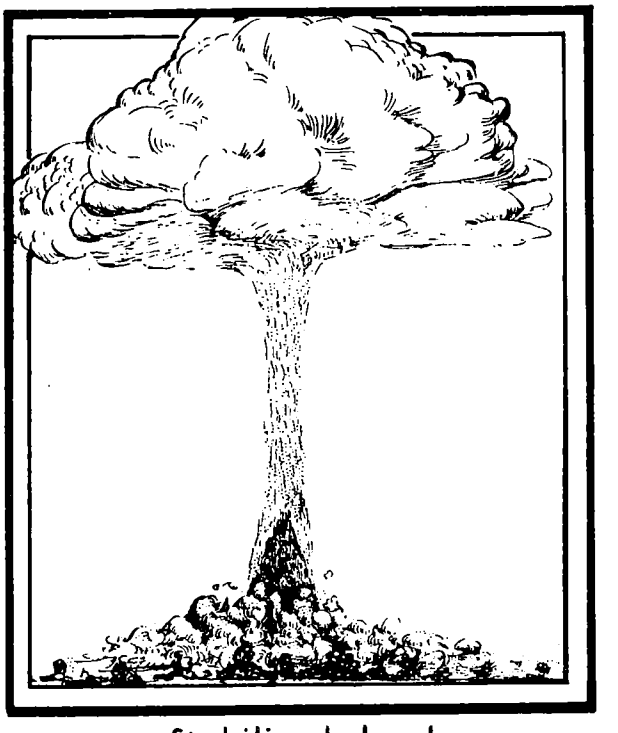


Fireball to initial cloud
(10 seconds after burst)

Growing cloud
(1 minute after burst)



Growing cloud
(3 minutes after burst)



Stabilized cloud
(4 to 14 minutes after burst)

Figure 2-1. Cloud development of a typical surface nuclear burst.

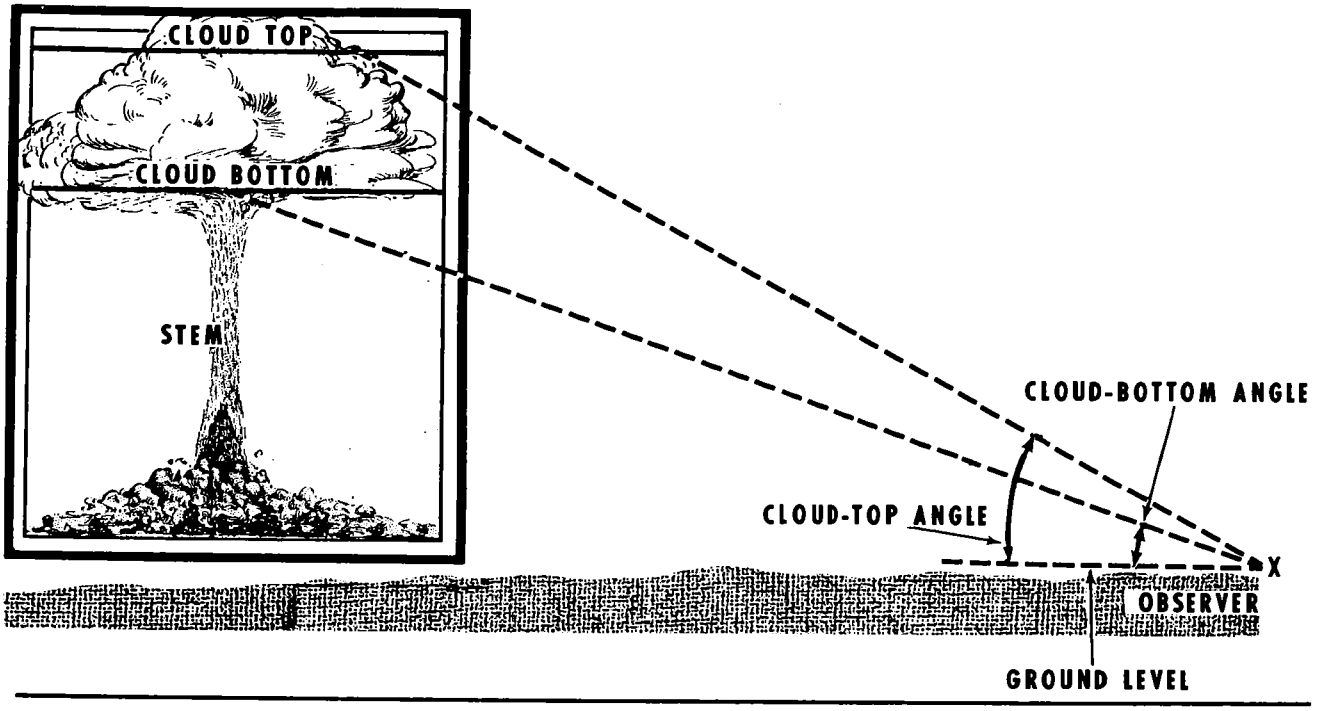


Figure 2–2. Stabilized nuclear burst cloud (surface burst).

Note. As a safety measure, the observer will stay in a prone position on the ground or in cover until the arrival of the sound of the explosion (bang) or until the shock wave has passed. The observer will be estimating or measuring the time after the flash during this flash-to-bang time (para 2–5). No cloud measurements are made until after the bang is heard and the intense illumination has passed. Individuals ignoring this warning may be subjected to severe blast effects and eye damage.

★*c. Azimuth from the observer to the mushroom stem or cloud center* is measured and reported to assist the TOC of higher headquarters in locating ground zero (para 2–9) of the burst. Measure azimuth immediately after the passage of the shock wave or bang.

d. Width of the nuclear burst cloud is the angular dimension in mils or degrees of the nuclear burst cloud diameter as measured by an observer 5 minutes after the time of detonation.

e. Cloud angles are discussed below—

(1) *Stabilized cloud-top angle* is the vertical angle in mils or degrees measured from ground zero to the top of the stabilized cloud. (If ground zero is not discernible to the observer, then ground level is used.) This measurement is made approximately 10 minutes after the burst (fig. 2–2).

(2) *Stabilized cloud—bottom angle* is the vertical angle in mils or degrees measured from ground zero or ground level to the point of intersection of the stabilized cloud and the stem. This measurement is made approximately 10 minutes after the burst (fig. 2–2).

Note. If angles cannot be measured, the cloud-top height or cloud-bottom height (measured in meters or feet above the surface of the ground) may be obtained from measurements reported by observers in aircraft. These measurements should also be made approximately 10 minutes after the burst.

f. Height of burst refers to the position of the nuclear burst relative to the surface (earth or water). The exact height of burst of enemy-delivered nuclear bursts is desirable to know but may be virtually impossible to ascertain with present observational techniques. The trained observer can, however, discriminate between the obvious high airburst and the contact surface burst (para 2–5), and leave the transition zone as an area of doubt to be resolved by other means such as the presence or the absence of a crater.

g. Ground zero is the point on the surface of land or water at, or vertically below or above, the center of burst of a nuclear weapon.

h. Crater dimensions caused by a surface or subsurface burst will seldom be measured by personnel on the ground until some time after the danger of radiation has passed. Observers in aircraft, however, may be able to estimate the dimensions of the crater.

i. Illumination time is the interval of time between the instant of detonation and the cessation of the brilliant light of the explosion during the fireball stage of the nuclear cloud development.

2–9. Ground Zero Location

a. Unit Level. Under conditions of nuclear warfare, unit commanders at all echelons are interested in obtaining a quick "gross" fix on the location of ground zero (GZ) for any nuclear burst that is close enough to be observed. This information is used by the commander in making his estimate of the situation and in determining what impact, if any, the burst will have on executing his assigned mission. The location of GZ therefore may be determined in several different ways simultaneously at the various levels of command. Locally, the commander may be able to ascertain location of GZ of very small nuclear explosions by direct observation. If so, the GZ location will be reported as indicated in paragraph 2–2*b* (letter item F). For larger yields and more distant nuclear bursts, the unit can use the azimuth and flash-to-bang distance (fig. 2–4) from its observation point to determine GZ location.

b. Operations Center Level. Generally, units reporting large nuclear detonations will be from 10 to 50 kilometers (km) from ground zero and will report flash-to-bang time, coordinates of observer location, and azimuth to the nuclear burst cloud along with other items specified in the nuclear burst report. These data will be plotted and the GZ locations determined from intersecting azimuths from two or more observation points. When azimuth data are incomplete, GZ location can also be determined from intersecting arcs using radii of flash-to-bang distances from two or more observation points. Ground zero will normally be located by the intersection of azimuths from two or more observation points using reports data corresponding to the same date and time of detonation. Combinations of arcs using radii of flash-to-bang distances and azimuths from observation points can also be used.

2–10. Nuclear Burst Parameters for Yield Estimation

a. General. Nuclear burst parameters have been correlated with yield and are presented in nomograms, each of which is an independent means of determining an estimated yield. If any of the following combinations of burst parameters (listed in order of decreasing reliability) are known, an estimated yield can be determined from nomograms:

★(1) Distance to ground zero (or flash-to-bang time) and nuclear burst angular cloud width, measured at 5 minutes after detonation.

(2) Stabilized cloud-top or cloud-bottom height.

(3) Distance to ground zero (or flash-to-bang time) and stabilized cloud-top or cloud-bottom angle.

(4) Illumination time (least reliable—determined from para 2–11).

★*b. Nuclear Burst Angular Cloud Width.*

★(1) Figure 2–3 is used to determine yield from nuclear burst angular cloud width and distance to ground zero (or flash-to-bang time). The right-hand scale is the nuclear burst angular cloud width in mils or degrees, the center scale is the flash-to-bang time in seconds and the distance in kilometers to ground zero, and the left-hand scale is the yield in kilotons (KT).

★(2) To use figure 2–3, place a hairline from the point of the right-hand scale, representing the nuclear burst angular cloud width at 5 minutes after detonation, through the point on the center scale representing flash-to-bang time or distance to ground zero. At the point of intersection of the hairline and the left-hand scale, read the yield.

★(3) For example, the data determined by the observer for the NBC 1 report discussed in paragraph 2–3 indicated a flash-to-bang time

of 60 seconds and a nuclear burst angular cloud width of 280 mils. To estimate the corresponding yield by using the nomogram, connect 280 mils on the right-hand scale and 60 seconds on the center scale with a hairline; at the point of intersection of the hairline and the left-hand scale, read a yield of about 50 KT.

c. Stabilized Cloud-Top Height or Cloud-Bottom Height. Cloud-top or cloud-bottom height, when stabilized, can be closely measured by an observer in an aircraft. If cloud width or angles cannot be measured, the use of tactical aircraft for this purpose may be justified. Measurements (in meters or feet above the surface of the ground) should be made at approximately 10 minutes after the burst. Figure 16, TM 3–210, is used to correlate these measurements with yield.

d. Stabilized Cloud-Top Angle or Cloud-Bottom Angle.

(1) Figure 2–4 is used to determine yield from distance-to-ground zero (or flash-to-bang time) and either stabilized cloud-top angle or stabilized cloud-bottom angle measurements. The right-hand scale gives the flash-to-bang time in seconds on the left side and distance in kilometers to ground zero on the right side. The center scale is the cloud-top angle or cloud-bottom angle, measured in mils on the left of the scale and in degrees on the right of the scale. The left-hand scale is actually two scales. On the left of the left-hand scale are listed the yields to be read when using the stabilized cloud-bottom angle measurements; on the right of this left-hand scale are listed the yields to be read when using the stabilized cloud-top angle measurements.

(2) To use figure 2–4, place a hairline through the point on the right-hand scale representing distance-to-ground zero or flash-to-bang time and through a point on the center scale representing either the cloud-top angle measurement or the cloud-bottom angle measurement. At the point of intersection of the hairline and the left-hand scale, read the yield. If a cloud-top angle measurement is used on the center scale, read the yield on the right side of the left-hand scale entitled "Yield (Cloud Top)." If a cloud-bottom angle measurement is used, read the yield on the left side of the left-hand scale entitled "Yield (Cloud Bottom)."

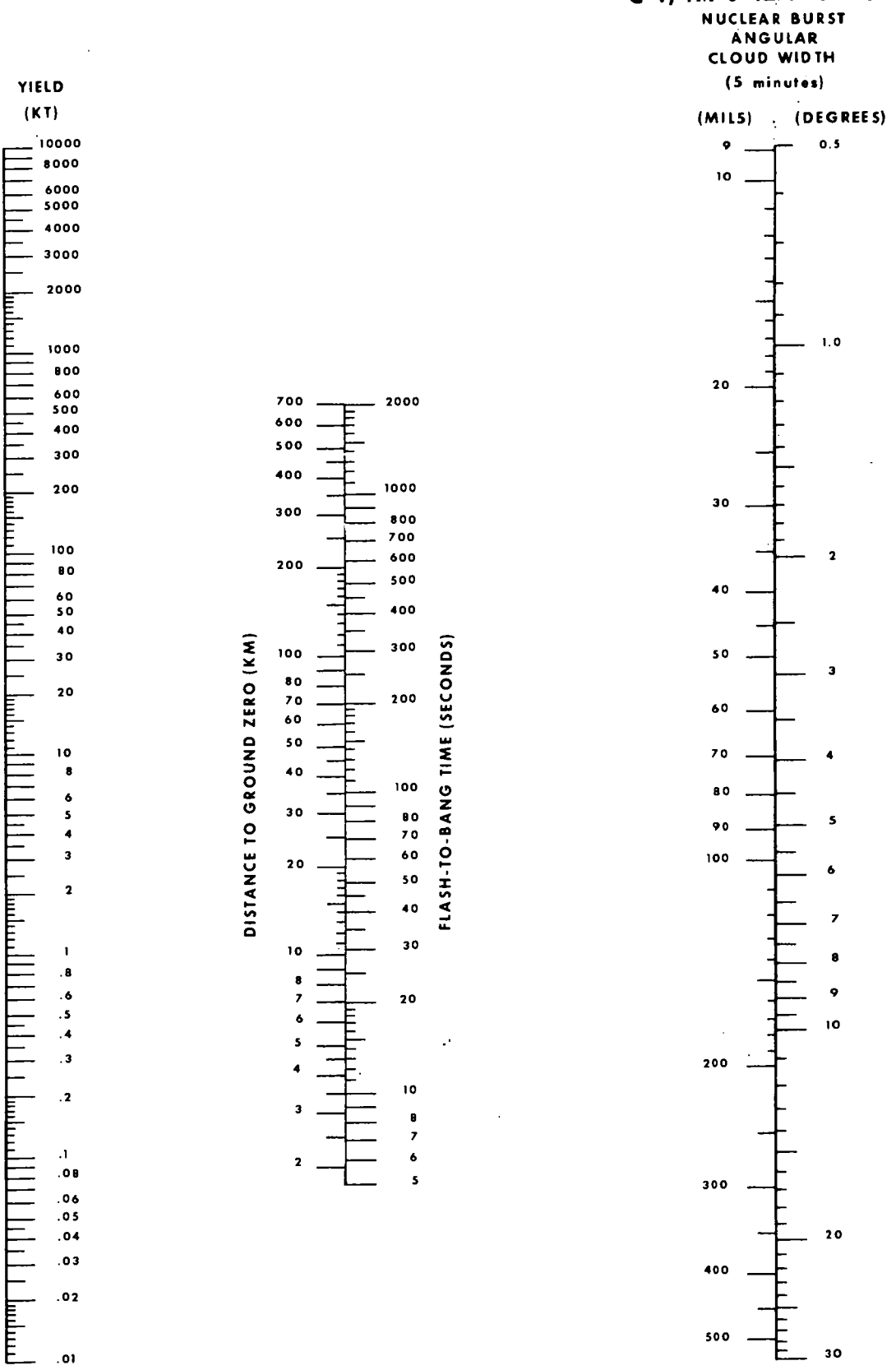
(3) For example, an observer reports a flash-to-bang time of 120 seconds, angle to cloud top of 300 mils, and angle to cloud bottom of 200 mils. Place a hairline from 120 seconds on the flash-to-bang time scale through 300 mils on the left side of the angle scale; the yield is read as 50 KT on the right side (cloud top) of the yield scale. Place a hairline from 120 seconds on the flash-to-bang time scale through 200 mils on the left side of the angle scale; the yield is read as 55 KT on the left side (cloud bottom) of the yield scale. It is emphasized that these yield calculations are field estimates.

2–11. Illumination Time

a. As a field expedient, yield may be estimated from the measurement of the illumination time of a nuclear burst, especially during hours of darkness or poor visibility. However this method should be used *only* if it is impossible to obtain cloud parameters as discussed above, since this method only gives a yield estimate on the order of a factor-of-10. Techniques for measuring illumination time will vary, depending on the situation, but under *no circumstances* should the observer attempt to look directly at the fireball since this can result in permanent damage to the eyes. The illumination time may be estimated by the observer who has taken shelter in a foxhole by noting the light reflected into the foxhole. The observer can look at the floor of the foxhole and still sense the duration of the flash or reflected light. Counting in seconds will probably be the most effective way of determining the illumination time since the "dazzle" (flash blindness) effect will preclude the reading of watches.

b. The data below show rough estimations of yield, using illumination time—

Illumination time (Seconds)	*Yield* (KT)
less than 1	1 to 2
1	2.5
2	10
3	22
4	40



★*Figure 2–3. Yield estimation (flash-to-bang time or distance to ground zero versus nuclear burst angular cloud width at 5 minutes after detonation).*

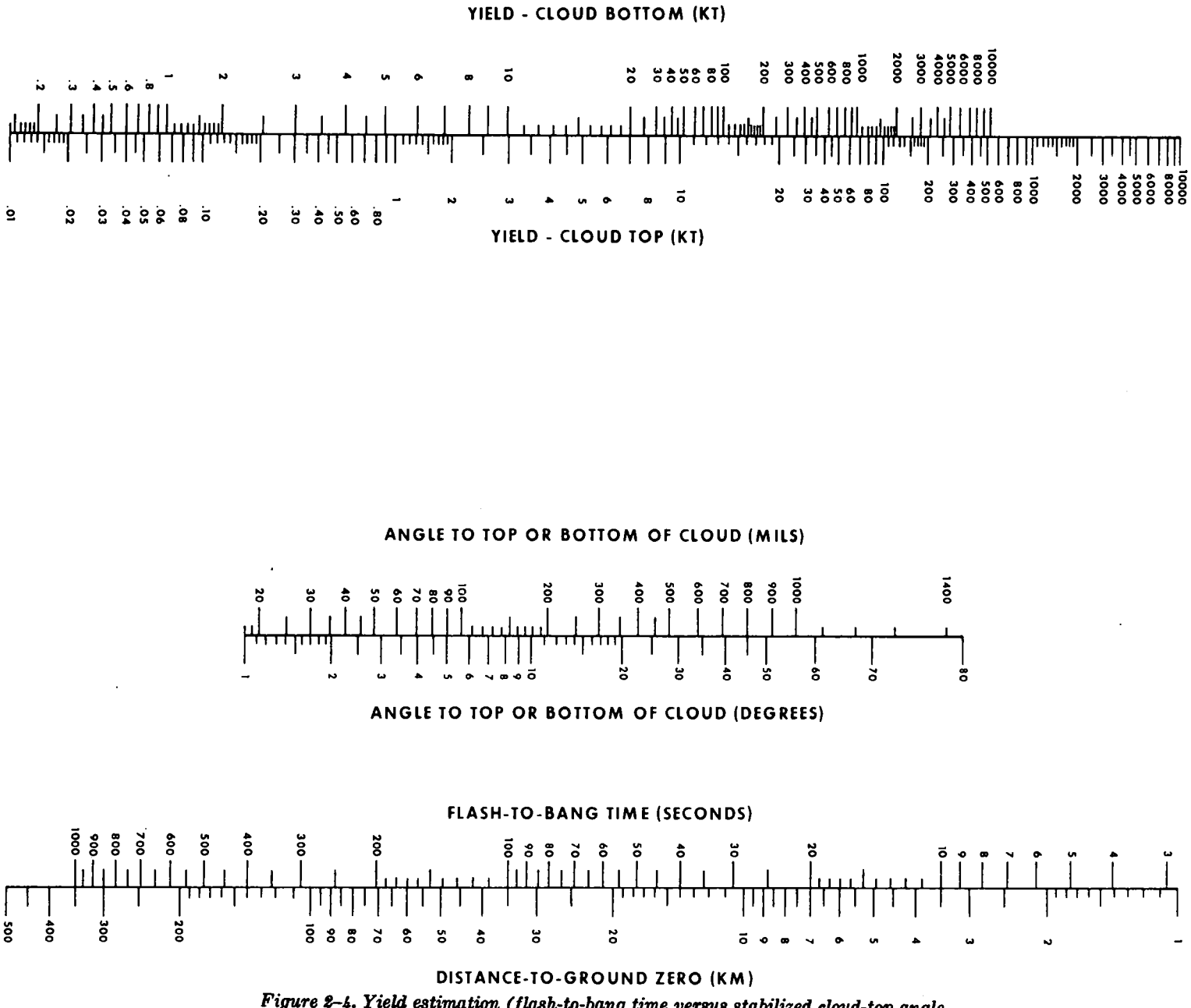

YIELD - CLOUD BOTTOM (KT)
YIELD - CLOUD TOP (KT)
ANGLE TO TOP OR BOTTOM OF CLOUD (MILS)
ANGLE TO TOP OR BOTTOM OF CLOUD (DEGREES)
FLASH-TO-BANG TIME (SECONDS)
DISTANCE-TO-GROUND ZERO (KM)

Figure 2-4. Yield estimation (flash-to-bang time versus stabilized cloud-top angle or stabilized cloud-bottom angle).

Illumination time (Seconds)	*Yield* (KT)
5	60
6	90
7	125
8	160
9	200
10	250
12	325
14	475
16	700

2–12. Nuclear Yield Calculator

★The M4A1 nuclear yield calculator, a component of the M28A1 nuclear calculator set, is designed to provide a rapid method for calculating nuclear yield from a nuclear burst. The old M4 nuclear yield calculator, a component of the M28 nuclear calculator set, should not be used because it gives a yield estimate that is inaccurate.

a. General. The calculator permits estimation of yield when the illumination time is known and when the flash-to-bang time (or distance from burst) and any one of the following parameters are known:

(1) Stabilized cloud-top angle.

(2) Stabilized cloud-bottom angle.

★(3) Nuclear burst angular cloud width (measured at 5 minutes after the burst).

b. Description. Instructions for the use of the M4A1 calculator are given on the back of the calculator. The revised TB CML 92 will describe the M4A1 nuclear yield calculator and illustrate its use with detailed example problems.

2–13. Training

a. Individual Training. Unit commanders will insure that selected individuals are trained in methods of determining ground zero location, type of burst, angular elevation of the top and bottom of the stabilized cloud, and the width of the nuclear burst cloud. In addition, all individuals will be trained to acquire a basic understanding of fallout hazards and protective measures. Refer to FM 21–41 for further information on individual training.

★*b. Unit Training.* Nuclear burst situations will be integrated into unit training exercises. Standing operating procedures will contain instructions on actions to be taken when units observe nuclear burst. Refer to FM 21–40 and FM 21–48 for further information on unit training. Training Film 3–4100, Nuclear Burst Reporting, may be used in unit training.

CHAPTER 3

RADIOLOGICAL MONITORING

★(NATO STANAG 2103, ABCA SOLOG 123)

Section I. INTRODUCTION

3-1. General

Radiological monitoring is the act of detecting the presence of radiation and measuring it with radiac instruments. The radiac instrument used in monitoring radiologically contaminated areas is the survey meter. No special organization is required for monitoring.

3-2. Operational Value of Monitoring

Monitoring is included in normal intelligence and reconnaissance activities and provides the following:

a. Warning. Monitoring provides warning of a hazard that otherwise might go undetected. For example, monitoring alerts the command to the arrival of fallout or alerts units on the move when they contact a contaminated area.

b. Unit Radiological Information.

(1) *Small units.* Unit monitors keep the unit commander informed of the degree of radiological hazard in his unit area.

(2) *Brigade, battalion, and comparable units.* Monitoring reports from subordinate units are used in conjunction with fallout predictions in developing radiological intelligence.

★(3) *Division and higher or similar organizations.* Monitoring reports, screened by intermediate headquarters, are one of the forms of information used by major organizations having area responsibilities in developing the radiological contamination overlay. If sufficient data are collected from monitoring efforts and if reports are not delayed in transmission, a radiological survey may not be required.

Section II. AREA MONITORING

3-3. General

Once nuclear operations have commenced, company/troop/battery units (or smaller units operating independently) monitor for radiation. Monitoring may be either periodic or continuous. Units monitor continuously under conditions listed in paragraph 3-4*b*; otherwise, periodic monitoring is performed.

3-4. Types of Monitoring

a. Periodic Monitoring. Periodic monitoring is the periodic check of the units area for radiation. The purpose of periodic monitoring is to assure the commander that his unit area is not contaminated and to warn him if contamination arrives. All units (normally platoon level and above) should routinely monitor a designated point in their unit area a minimum of once during each 1-hour period. The unit SOP should give detailed guidance on monitoring procedures and times so that subordinate units will monitor at essentially the same time and in the same manner. Units having several survey meters on hand may need to use only one instrument for this purpose.

b. Continuous Monitoring. Continuous monitoring is a continuous surveillance for radiation in the unit area of operations or along a route of march and is performed by units, using the techniques established in paragraph 3-5. Continuous monitoring requires that the monitor have the survey meter with him and turned on at all times; the frequency of read-

ings will depend upon the current situation. For example, the monitor will take more frequent readings when fallout is actually arriving on the unit position than he will if the unit is simply warned that it may be in the fallout area. Units initiate continuous monitoring in the following situations:

(1) When a fallout warning (NBC 3 report) is received.

(2) When ordered by the unit commander.

(3) After a nuclear burst has been sighted, heard, or reported.

(4) When the unit is moving.

(5) During reconnaissance and patrol activities.

(6) When radiation above 1 rad/hr is detected by periodic monitoring.

Units discontinue continuous monitoring on orders from higher headquarters or when the dose rate falls below 1 rad/hr (except for units on the move).

3–5. Monitoring Techniques

Monitoring techniques vary, depending upon such factors as ground dose rate, operational or tactical conditions, dose status of monitor, type of survey meter, and whether the monitor is stationary or moving. The technique used must provide sufficient information to allow evaluating agencies to calculate the ground dose rate at the monitor's location. A form devised for recording data is described in paragraph 3–15.

a. Direct Technique. The direct determination of ground dose rate is the simplest and most precise of the monitoring techniques. The unshielded ground (outside) dose rate may be determined directly by standing at the desired location, holding survey meter waist high in a vertical position (face up), turning with the survey meter in all directions, and recording the highest dose rate reading observed. The preferred procedure is to take readings in the open at least 10 meters away from buildings, other large structures, or objects that may shield out a portion of the radiation. If there are points of operational interest where this procedure cannot be used, additional readings can be taken at those points. Thus, if a road through a narrow cut or defile is of operational interest, readings should be taken both in the open near the cut and in the cut. In cities or built-up areas, readings are taken in the center of the streets or at street intersections. In all these cases no correlation factor data (para 3–6) are required since the readings are representative of the area of interest. Safety considerations may preclude the direct determination of ground dose rates except—

(1) When in low dose-rate areas.

(2) While monitoring for the initial detection of contamination.

(3) While obtaining transmission factor data.

(4) While moving through a contaminated area on foot.

b. Indirect Technique.

(1) *Monitoring inside shelters.* Within the contaminated area, monitoring will normally be performed from within shelters or fortifications. The monitoring reading is obtained by noting the highest dose rate measured by the survey meter when it is held in the center of the shelter, 1 meter above the floor, and pointed in all directions.

(2) *Monitoring inside vehicles.* Monitors mounted in ground or aerial vehicles use the ground or aerial survey procedures established in chapter 4 to obtain monitoring information.

3–6. Correlation Factor Data

★*a. Requirement.* All monitoring reports, except those made using the direct technique of paragraph 3–5*a*, must include correlation factor information so that shielded dose rates can be converted to ground dose rates. If the situation permits, it is preferable to determine the correlation factor directly (para 3–6*b* and 4–21). When correlation factors cannot be obtained directly, the type of structure or vehicle should be identified in the monitoring report and the appropriate correlation factor should be obtained from figure 4–4.

b. Procedure. The correlation factor data required consist of two dose-rate determinations that must be made within 3 minutes of each other. One is a direct determination of ground dose rate made at a location 10 meters from the shelter (para 3–5*a*), if possible, unless the shelter is underground. The other is a reading made with the survey meter held in the center

of the shelter, 1 meter above the floor, and pointed in all directions.

c. Example. A company monitor is located in an open front shelter dug into the side of a hill. Since there is no published correlation factor for a shelter of this type, he has selected a spot outside the shelter at which to read the ground dose rate. A nuclear burst occurs several kilometers away and about 30 minutes later the monitor detects the arrival of fallout. After the completion of fallout, the monitor takes a dose-rate reading of 2 rad/hr with the survey meter at the center of the shelter, 1 meter above the shelter floor, and then goes immediately to the selected location outside the shelter and takes a ground dose-rate reading of 10 rad/hr. (He returns immediately to the shelter to avoid unnecessary exposure.) The two dose-rate readings were made within 3 minutes of each other; thus the correlation factor data for this shelter are—

Inside dose rate (ID) = 2 rad/hr.
Outside (ground dose rate (OD)) = 10 rad/hr.

The correlation factor is determined as shown below:

$$\text{Correlation factor (CF)} = \frac{\text{OD}}{\text{ID}} = \frac{10 \text{ rad/hr}}{2 \text{ rad/hr}} = 5.0$$

Note. In this example the transmission factor (TF) is 1/5 (see para 1-8c); that is, 1/5 the outside dose rate was received inside the shelter.

3-7. Personnel Requirements

The requirement for monitors is widespread throughout the battlefield because of the need for radiological information. Reconnaissance and intelligence agencies (including aerial observer personnel, reconnaissance and scout platoons, scout sections, patrols and the area military police) monitor for radiation as a normal part of their mission. Command responsibilities for maintaining a monitoring capability are described in paragraph 1-11.

a. Individual Training. (See FM 21-41.) All military personnel should be familiar with the basic capabilities and characteristics of radiac instruments. Selected Army and Marine Corps personnel will be given specialized training in radiological survey and monitoring. See Army Subject Schedule 3-18 for guidance.

b. Unit Training. (See FM 21-40 and FM 21-48.)

(1) Unit SOP's should include monitoring procedures and measures for defense against radiological contamination.

(2) Field exercises and command post exercises (CPX's) should include fallout situations that require monitoring and reporting activities.

(3) Army training tests (ATT's) and operational readiness training tests should include situations that require units to conduct monitoring activities and employ appropriate measures for defense against radiological contamination.

3-8. Equipment Requirements

The equipment necessary for monitoring is listed below. Also, a dosimeter, such as radiacmeter IM-93 (*)/UD, IM-147/PD (TM 11-6665-214-10), or IM-143/PD (USMC), must be carried by the monitor for purposes of radiation exposure control (ch 6). The radiac instruments should be properly calibrated before use.

a. Radiological Survey Meter. The radiacmeters IM-174A/PD (Standard A) and IM-174/PD (Standard B) are radiological survey meters that measure gamma radiation in the range of 1 to 500 rad/hr.

b. Watch. Time of reading is an essential part of a monitoring report. Any watch that can be read to the nearest minute is satisfactory.

c. Radiological Data Sheet. DA Form 1971-R (Radiological Data Sheet—Monitoring and Point Technique) (fig. 3-1) (image size, 7" × 9⅝") and DA Form 1971-1-R (Radiological Data Sheet—Route Technique or Course Leg Technique) (Ground and Aerial Survey) (fig. 4-3) (image size, 7" × 9⅝") will be used for recording data (para 3-15). DA Forms 1971-R and 1971-1-R will be reproduced locally on 8- × 10½-inch paper.

d. Map. Appropriate maps of the area to be monitored should be made available.

* Designates all models of the series.

3–9. Survey Meter Checks

a. Preoperational Check. The radiacmeter IM–174A/PD is an ion-chamber type radiac instrument. TM 11–6665–232–12 establishes a preoperational check to insure that the survey meter is functioning properly. It is imperative that this check be made each time the survey meter is turned on or whenever erratic readings are obtained during monitoring.

b. Zeroing. Ion-chamber type radiacmeters may be "zeroed" in a contaminated area. TM 11–6665–232–12 establishes procedures for this operation. It is essential that the survey meter be zeroed before each set of monitoring readings. If this procedure is not followed, electronic fluctuations can cause significant errors in monitoring readings.

Section III. REPORTING AND RECORDING

3–10. General

The primary purposes of monitoring are to allow warning of all personnel of the arrival or presence of a radiological hazard and to provide a basis for prompt action by the commander to minimize the hazard.

3–11. Format for Monitoring Reports

★*a. Format.* The format for monitoring reports follows the format established in STANAG 2103 (app C). Only that part (NBC 4) which pertains to monitoring reports is presented in this chapter. Monitoring reports contain the location of the reading; the dose-rate reading (identified as rad/hr; the words "initial," "increasing," "peak," or "decreasing" may be added; correlation factor data may be included if shielded dose-rate readings are reported); and the date and time of the reading in either LOCAL or ZULU time. The format for monitoring reports follows:

★ Type of Report: NBC 4 (Nuclear)
Q. Location of reading.
R. Dose rate (rad/hr). The words "initial," "increasing," "peak," or "decreasing" may be added. (Include correlation factor information if shielded dose-rate readings are reported.)
S .Date and time of the reading in LOCAL or ZULU time (state which).

Note. Letter items Q, R, and S may be repeated as often as necessary.

b. Sample Monitoring Report. A sample monitoring report as submitted by a monitor, following the format of *a* above, is shown below:

Precedence*
Date/Time (LOCAL or ZULU, state which)
Security Classification
From
To
★Type of Report: NBC 4 (Nuclear)
Q. TU 054066
R. 50 shielded (foxhole)
S. 161310 Z
Q. TU 056068
R. 70 peak
S. 161350 Z

* As appropriate or as per unit. SOP.

3–12. Automatic Reports

Proper functioning of the radiological contamination information collection effort requires that all units submit certain automatic monitoring reports. These reports provide the minimum essential monitoring information for warning, survey planning, and hazard evaluation purposes. Automatic reports are submitted through command or intelligence channels to the TOC of the major command having area responsibility for the location in which the monitoring information was taken. For example, a corps unit located in a division area would submit monitoring reports to division. Intermediate headquarters screen these reports and forward only those which are necessary to describe the radiological contamination hazard in areas of responsibility.

a. Contact Report. Warning units of approaching fallout or of previously undetected contamination is a primary step in avoiding casualties or combat ineffectiveness from radiation hazards. Fallout warning or contaminated area warning, to be meaningful, must be based upon information from units that initially contact the radiation hazard. A knowledge of the area within which fallout is arriving and the change in its perimeter as the area expands downwind from ground zero is necessary for survey control, traffic control, and other activities. All units will submit contact reports with IMMEDIATE precedence whenever an

initial ground dose rate of 1 rad/hr or more is detected in an area. These reports will provide the basis for issuing fallout and contaminated area warnings throughout the major command. Intermediate headquarters will screen and evaluate these reports and reduce the precedence if the hazard has already been detected and reported.

b. Peak Dose-Rate Report. At locations receiving fallout, the dose rate will steadily rise until it reaches a peak and then will decrease as the contamination decays. (*Caution should be used when complying with this peak dose-rate criterion. In some cases, the dose rate may fluctuate for a short time before beginning a constant decrease.)* Units will report this peak dose rate or in the event the survey meter goes off scale, they will report when the survey meter comes back on scale after peaking. (Monitors should not necessarily remain in the contaminated areas waiting for the meter to come back on scale. However, if the monitor is in the area when the meter comes back on scale, this time should be reported.)

★*c. Special Reports.* SOP's or other standing instructions may establish special automatic reports. These special reports are for evaluation by the TOC of the contamination hazard for the purpose of inviting command attention to areas of serious concern. Since the operational situation, unit radiation status, and similar considerations determine the criteria for these special reports, they are not specified in this manual. Reports of this type may be required when the ground dose rate goes above a specified value.

Example: The radiation dose status of subordinate units and other conditions for an operation are such that areas where dose rates are above 10 rad/hr will be of serious concern. Dependent upon the unit radiation status, exposure to dose rates of this order of magnitude for any appreciable period of time (hours) may cause the unit to exceed moderate and emergency risk criteria established by the commander and result in the unit being classified into a more serious radiation status category (table 6–2). Thus, automatic monitoring reports will be required when the ground dose rate goes above 10 rad/hr.

3–13. Other Reports

Other reports on a nonautomatic basis may be required to properly evaluate a radiological contamination hazard. Requirements for these reports are established by directives, SOP's or other standing instructions that include report basis, precedence, reporting procedure, format, and communications channels.

3–14. Communications

a. Automatic Contact Report.

(1) The contact report described in paragraph 3–12*a* is forwarded with an IMMEDIATE precedence by the most expeditious means of communication available.

(2) A warning will be broadcast over the warning net by major commands upon verification of fallout occurring or detection of previously unreported radiological contamination that poses a hazard to personnel.

b. Special Automatic Reports. Headquarters below division level specify communications for automatic reports originating in their areas of responsibility. Artillery units use artillery nets or the area communications system. The highest precedence should be used consistent with other communication and operational requirements.

c. Other Reports. Directions establishing these reports will specify communications channels and precedence.

3–15. Recording

The radiological data sheet (para 3–8*c*) is designed for recording radiological data obtained by monitoring and survey. Space is provided on DA Form 1971–R for monitoring data and for survey data when the point or preselected dose rate techniques are used. Instructions for use of DA Form 1971–1–R are given in paragraphs 4–13 and 4–22. Headings provided in blocks are self-explanatory; in using the form, any heading not applicable to the situation may be lined through by the monitor. Space is provided for use of the control party, as indicated, for entry of the correlation factor and normalized data. The REMARKS block is to be used by the monitor in providing any ad-

RADIOLOGICAL DATA SHEET MONITORING ~~AND POINT TECHNIQUE~~ (FM 3-12)				DATE 5 JUNE 1966			PAGE NO. 1	NO. OF PAGES 1
~~SURVEY PARTY OR~~ MONITORING UNIT DESIGNATION ALFA-ONE				MONITOR (Print name) CPL JAMES JONES				
MAP USED GERMANY SHEET 252 1:50,000				~~TYPE OF VEHICLE OR~~ OTHER SHIELDING FOXHOLE			INSTRUMENT TYPE IM-174A/PD	
READING NO.	LOCATION	TIME	DOSE RATE (rad/hr)	DO NOT USE[1]	READING NO.	LOCATION	TIME	DOSE RATE (rad/hr)	DO NOT USE[1]
1	NV188797	0900	6	H+1	16				
2	"	0915	PEAK 17	266	17				
3	"	0945	14		18				
4	"	1015	12		19				
5					20				
6					21				
7					22				
8					23				
9					24				
10					25				
11					26				
12					27				
13					28				
14					29				
15					30				

REMARKS

H-HOUR = 0730 $\eta = 0.8$

$CF = \frac{60}{6} = 10$ $NF(0915) = 1.56$

$OCRF = 10 \times 1.56 = 15.6$

CORRELATION FACTOR DATA

LOCATION	READING NO.	DOSE RATE (rad/hr) INSIDE	DOSE RATE (rad/hr) OUTSIDE	CF[1]	LOCATION	READING NO.	DOSE RATE (rad/hr) INSIDE	DOSE RATE (rad/hr) OUTSIDE	CF[1]
NV188797	1	6	60	10					

[1] DO NOT USE. For control party use only.

DA FORM 1971-R, 1 JAN 63 Replaces DA Form 1971-R, 1 Nov 58, which is obsolete.

Figure 3-1. Completed radiological data sheet (monitoring).

ditional information that will be of value to the control party; this block is also to be used by the control party to enter time of burst and to show computations of the normalizing factors (NF) (para 7–21) and the overall correction factors (OCRF) (para 7–22). A completed radiological data sheet, showing monitoring data and computations, is illustrated in figure 3–1.

Section IV. MONITORING OF PERSONNEL, FOOD, WATER, AND MATERIEL

3–16. General

a. Radiacmeters for Monitoring Personnel, Food, Water, Materiel, and Occupied Old Contamination Areas. The radiacmeter of the AN/PDR–27 ( ) radiac set (Standard A), or instrument with a similar range, is used in monitoring personnel, food, water, and materiel. It is equipped with a separate probe and earphones to facilitate monitoring. The probe is held near the surface to be monitored. If contamination is encountered, an increase in the number of clicks will be heard in the earphones.

b. Acceptable or Safe Levels of Contamination. Acceptable or safe levels of remaining radioactive contamination should be established by the commander on recommendations of the medical officer. In the absence of specific guidelines, a dose-rate reading as close to background (the environmental reading) as is practical will be considered acceptable.

3–17. Monitoring of Personnel

★When operational areas are contaminated, personnel monitoring stations should be established as soon as practicable at the lowest unit level commensurate with radiac capability, and all personnel leaving the contaminated areas should be monitored. Personnel who are contaminated will be required to decontaminate themselves, except those physically disabled. Personnel monitoring is performed to detect contamination on the body. This will serve as a guide for decontamination procedures. Proper monitoring of personnel consists of complete and careful checking of those parts of the body and clothing most susceptible to contamination (hands, face, shoes, sleeves, and trousers); and the use of a systematic monitoring procedure, that is, monitoring the hands first, working up to the face and head, then proceeding down the body to the shoes. The probe window of the radiacmeter should be held 2 to 3 centimeters (about 1 inch) from the surface being monitored for beta-gamma contamination. Care should be taken not to contaminate the probe by touching it to the surface being monitored. The probe should be moved along the surface with a slow, steady motion in proceeding with *a* through *d* below. If the level of contamination causes the needle to go off the 5 mrad/hr scale of the AN/PDR–27 ( ) set, the monitor should turn the selector switch to the next higher scale and orient the small probe parallel to the surface being monitored. The person being monitored should stand straight with feet spread apart about 30 centimeters (1 foot) and arms extended sideward with palms up and fingers straight.

a. Monitor both hands and forearms to the elbows with palms up; then repeat with hands and arms turned over.

b. Monitor the entire front of the body, starting at the top of the head; monitor the hair, forehead, nose, lips, neckline, torso, knees, and ankles carefully.

c. Repeat the monitoring from head to ankles from the back.

d. Monitor the sole of each foot.

3–18. Monitoring of Food

a. Except in rare cases of induced radiation, rations in cans or other sealed containers are not in danger of radiological contamination. As the contamination will normally be limited to the outer surface of the sealed containers, decontamination is accomplished by removing the contamination from the outer surface. This may be done by removing outer packaging or by washing or scrubbing under running water. Under no condition should sealed containers be

opened until they have been decontaminated and the effectiveness of decontamination established.

b. Food not protected in sealed containers must be suspected of contamination until monitored. All foods should be removed from the contaminated area to a clean area. Potatoes and hard-skinned fruits and vegetables can be decontaminated by washing or scrubbing under running water, followed by the peeling or scraping and washing again. Running water, if creek or stream, should be checked for contamination especially since the water source may be in the GZ or fallout area. All visible dirt should be brushed from meats and fish; washing is not recommended. Meat or fish should be monitored with an AN/PDR–27 ( ) radiac set, or instrument with a similar range, with the probe open and held approximately 1 centimeter (about one-half inch) from the surface of the food. If the reading exceeds background, then the food should be decontaminated if possible. A thin layer of meat can be removed and the food remonitored. A reduction in dose rate would indicate that the contamination was confined to the surface of the food. The cutting away process can be continued, within practical limits, until the dose-rate reading is acceptable (para 3–16*b*). If the dose rate is within acceptable limits initially or after the outer layer or layers have been removed, the food can be safely consumed. As prepared food in open containers will probably be contaminated, it should be disposed of by burial or as otherwise determined by designated medical personnel. Radiologically contaminated wash water and trimmings should be similarly disposed of.

c. Any food that has been exposed to radiological contamination must be carefully monitored before and after decontamination. Foods in which radioactivity has been induced can only be decontaminated by aging. Careful monitoring will determine the progress of radioactive decay during aging.

3–19. Monitoring of Water

Water that has been in a contaminated area or is suspected of being contaminated should be monitored and declared safe before it is used for drinking by personnel.

a. Decontamination of water is an engineer responsibility. Determination of the potability and approval of water is a responsibility of the Surgeon for Army units and is the responsibility of the Navy Medical Service for Marine Corps units.

b. Radioactive contaminants in water are not affected by boiling or by other water treatment methods designed for chemical or biological decontamination (TM 3–220).

c. Spring or well water should be used in preference to surface water. If it becomes necessary to use radiologically contaminated water (for example, lakes, ponds, rivers, and streams), the instructions set forth below should be followed and the water used only under these conditions.

(1) If the external radiation hazard permits operations in the area around the water point without a shelter, the water is suitable for consumption for a period not exceeding 1 week, provided that normal field purification methods have been accomplished.

(2) The IM–141/PDR–27J radiacmeter (TM 11–6665–209–15), or instrument with a similar range, may be used (probe open and held approximately 1 centimeter, about one-half inch, from the surface of the water) to give a qualitative indication of beta-gamma contamination.

d. IN AN EMERGENCY ONLY, water from a moving stream or similar source may be used, even though it contains radiological contamination, if it is filtered through a column of earth of at least 15 centimeters (6 inches), preferably 25 to 30 centimeters (10 to 12 inches); earth is obtained from nonradioactive sources; the column is supported by a fine mesh material to prevent passage of earth particles; and the resultant product is checked for radioactivity remaining in the filtered water. Subsequently, the water should be boiled or treated with iodine purification tablets or calcium hypochlorite to kill biological contaminants.

3-20. Monitoring of Materiel

a. Materiel that has been exposed to radiation or has been in a contaminated area must be monitored. This should be performed at a materiel monitoring station as near the contaminated area as possible. Materiel that is found to be contaminated should remain within a restricted area until the contamination either is removed or has decayed to background. In general, care should be taken when monitoring materiel to pay particular attention to those surfaces where the contamination is most likely to occur, such as the wheels, tires, and undersides of vehicles and aircraft, greasy surfaces, floors, and steps. Before an attempt is made to recover or evacuate contaminated materiel, a check should be made to determine the practicability of this action. If the contamination is such that it exceeds the capabilities of any unit to decontaminate the materiel to permit recovery and evacuation, the location should be noted and the next higher headquarters should be notified so that advice and assistance on decontamination or disposal may be obtained.

b. The probe window of the radiacmeter should be held about 2 to 3 centimeters (1 inch) from the surface being monitored for beta-gamma contamination. The probe should be moved along the surface with a slow, steady motion and held perpendicular to the surface being monitored.

CHAPTER 4

RADIOLOGICAL SURVEY

(NATO STANAG 2112, SEATO SEASTAG 2112)

Section I. INTRODUCTION

4-1. General

Radiological survey is the directed effort to determine the extent and dose rates of radiation in an area. A radiological survey is performed by a group comprised of a control party and one or more survey parties. The control party, consisting of one or more men, plans and directs the radiological survey and screens and transmits the data to the authority that ordered the survey. Normally, the control party will be located at battalion or higher level; in some situations establishment of control parties at company level may be required. The survey party, organized within the company/troop/battery CBR team, consists of a monitor and necessary support and security personnel. The material presented in this chapter is in agreement with STANAG 2112.

4-2. Operational Value of Survey

At division and higher echelons, monitoring reports may not provide sufficient information for evaluation of contaminated areas. Surveys may be necessary to provide the essential information. Surveys should be conducted only when the essential information cannot be obtained from monitoring reports and other sources because personnel required to conduct and support the survey must be diverted from their primary duties.

4-3. Survey Control Methods

The primary method of survey control is a centralized operation in which the authority ordering the survey provides the control party and the radiological data are reported direct to the control party. For example, if division orders an aerial survey, the CBRE of the TOC normally acts as the control party. Data are not screened, consolidated, or evaluated at intermediate headquarters. The alternate method of control is a decentralized operation directed through command channels and controlled by a subordinate command that furnishes the radiological data to the authority ordering the survey.

4-4. Radiation Safety

a. An operation exposure guide (ch. 6) for nuclear radiation is specified by the commander who ordered the survey. The control party will furnish the operation exposure guide to aerial survey parties and will calculate and furnish turn-back dose rates and turn-back dose for each ground survey party. (It is pointed out that these methods of calculation provide only rough estimates and are given for planning purposes only.)

b. The turn-back dose rate for a ground survey party is calculated as follows:

$$R_{tb} = \frac{2 \times OEG \times speed}{distance},$$

where:

R_{tb} = Turn-back dose rate,
OEG = Operation exposure guide,
speed = The speed at which the survey party will travel, and

distance = The distance the survey party will travel inside the fallout pattern (derived from a fallout prediction plot if no better information is available).

If the survey party encounters the turn-back dose rate, the party will immediately leave the fallout area by the same route used to enter it, unless instructed otherwise.

★*c.* The turn-back dose is calculated as follows:

$$D_{tb} = \frac{\text{operation exposure guide}}{2},$$

where D_{tb} = Turn-back dose.

If the turn-back dose is encountered by the survey party and the dose rate increases as the party travels forward, the party will immediately leave the fallout area by the same route used to enter it, unless instructed otherwise. If the dose rate decreases as the party moves ahead, the survey party will continue to perform its mission along the assigned route.

d. The use of the operation exposure guide by the aerial survey party requires judgment by the pilot in command. If the dose received is approaching the operation exposure guide, this officer must decide whether to fly the remaining course legs at a greater height above ground or to abort the remainder of the mission. The monitor will keep the pilot informed of the dose received during the mission.

★4–5. Airborne Radioactivity

Most contaminated particles in a radioactive cloud rise to considerable heights. Thus fallout may occur over an appreciable area and it may last for an extended period of time. A survey conducted before fallout is complete would be inaccurate inasmuch as contaminants would still be suspended in the air. For this reason, as well as the hazard to surveying personnel, radiological surveys should not be accomplished before completion of fallout (para 7–17).

4–6. Coordination

Wherever practicable, the control party will coordinate the activities of the survey parties with the units located in the area to be surveyed. If coordination by the control party cannot be accomplished because of lack of communications or other causes, the survey parties will be informed that the survey has not been coordinated. The survey parties will then be directed to coordinate, provided the situation in the area and the required time of completion of the survey permit.

Section II. AERIAL RADIOLOGICAL SURVEY

4–7. General

★Radiological contamination information can be obtained by use of the radiacmeter IM–174A/PD, held in a vertical position (face up), in rotary-wing or fixed-wing aircraft. Since aerial surveys are conducted rapidly and at a distance from the radiation source, the aerial survey party would be exposed to considerably less nuclear radiation than a ground survey party if an equivalent ground survey were conducted over the same area. Thus, aerial surveys can be employed over areas that have dose rates unacceptably dangerous to ground survey parties. Because of speed and flexibility, aerial surveys can be employed to advantage over large areas, over unoccupied areas of operational concern, over enemy occupied areas, and over areas of difficult accessibility to ground troops. Aerial survey is preferable when conducting surveys of large areas. The advantages of aerial survey over ground survey are speed and flexibility of employment; lower radiation doses to survey party members; and minimum requirements for equipment, personnel, and communications (FM 1–100). However, the dose-rate readings are not as accurate as those obtained by ground survey (para 4–15). Another disadvantage is that dose rates for specific points on the ground are not provided by aerial survey.

4–8. Simplified Aerial Survey

Battlefield conditions or the operational situation may preclude the preparation of the detailed radiological contamination overlay, and a simplified radiological contamination overlay may then be needed to satisfy the commander's

requirements. A simplified aerial survey will normally be required to complete the overlay.

★*a. Purpose.* The simplified aerial radiological survey is designed to provide the minimum essential information for evaluating the contamination hazard. The minimum essential information is that required to determine the outer limits of the area of militarily significant contamination (para 7–8*c*), a few dose rates in the most heavily contaminated parts of the area, and dose rates at points of operational interest. The simplified survey must be accomplished and the information provided to the control party as soon as possible after contamination is on the ground. The methods for determining when fallout is complete are covered in paragraph 7–17.

b. Techniques. The techniques of conducting simplified aerial surveys (FM 1–105) are the same as for detailed aerial surveys (para 4–9), with the following exceptions:

(1) The simplified survey requires considerably less detail than the detailed survey.

(2) The simplified survey may cover only those parts of the contaminated area which are of immediate operational concern.

(3) The control party preplans only the general area in which the simplified survey will be conducted. After arriving over the area; the survey party selects the check points, routes, and course legs.

(4) A debriefing is held by the control party after this survey is performed.

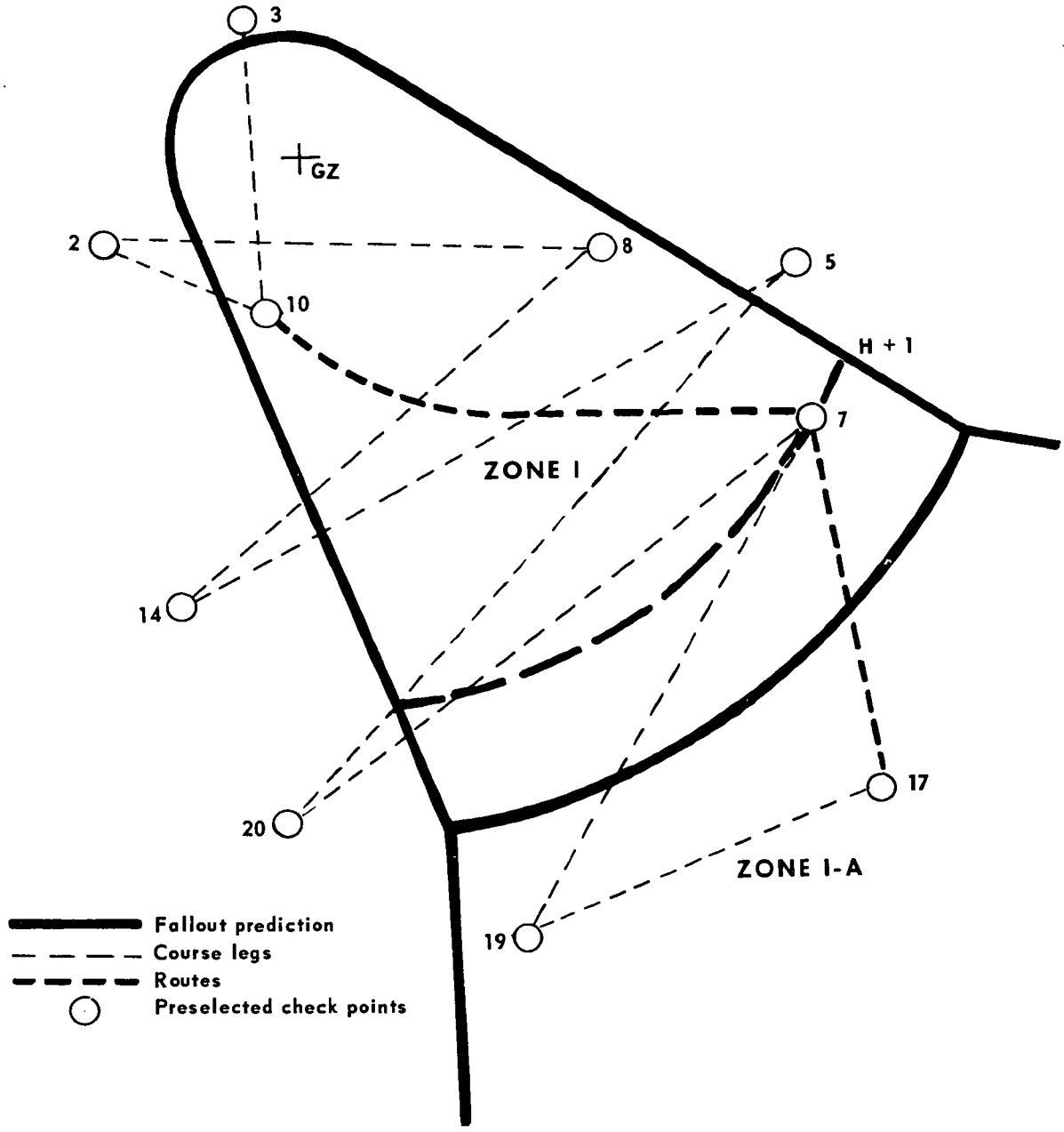
4–9. Detailed Aerial Survey

Simplified aerial survey information and monitoring reports do not normally provide sufficient information for the preparation of the detailed radiological contamination overlay, and a detailed aerial survey is usually required.

★*a. Planning.* The basis for planning a detailed aerial survey is the check point overlay. Check points that are easily identified from the air and on a map (small bodies of water, streams, or road junctions) are selected for the entire area of responsibility of the major command in advance by the chemical officer (or TOC representative) in coordination with the aviation officer. These check points are maintained as an overlay by these two staff officers. Then, when a survey requirement is established, the control party selects a series of course legs, routes, and points where data will provide sufficient ground dose-rate information to evaluate the contaminated area. Figure 4–1 shows an overlay plan for an aerial survey after a surface burst occurred in the division area. This overlay is to be used with figure 4–2 which illustrates a division area with selected check points.

b. Techniques. The techniques used to conduct detailed aerial surveys include: (1) the route technique, (2) the course leg technique, and (3) the point technique. In using the route technique, the pilot flies between two check points, following the route of some predominant terrain feature such as a road that connects the two check points (heavy dashed lines, fig. 4–1). In using the course leg technique, the pilot flies a straight line course (course leg) between two check points (thin dashed lines, fig. 4–1). The procedure followed in obtaining dose-rate information between check points is the same, using either the route technique or the course leg technique. When the dose-rate information obtained from use of either technique is processed, the result is a series of ground dose rates spaced at equidistant intervals along the path over which the aircraft was flown. The point technique is used to determine the ground dose rate at points of operational concern and is normally employed to obtain more precise dose-rate information at those points than can be obtained by use of other aerial survey techniques. Processed data from dose-rate information obtained using the point technique are ground dose rates existing at each of the selected points. The course leg and point techniques are described in *c* and *d* below.

c. Procedures for Using Course Leg Technique. The course leg technique requires that the aerial survey party fly a straight line course (course leg) between two check points. The pilot maintains as nearly as possible a constant height above the ground, a constant ground speed, and a straight flight direction between the starting and ending check points of each course leg.



★*Figure 4–1. Fallout prediction and planned aerial survey overlay (to be used with fig. 4–2).*

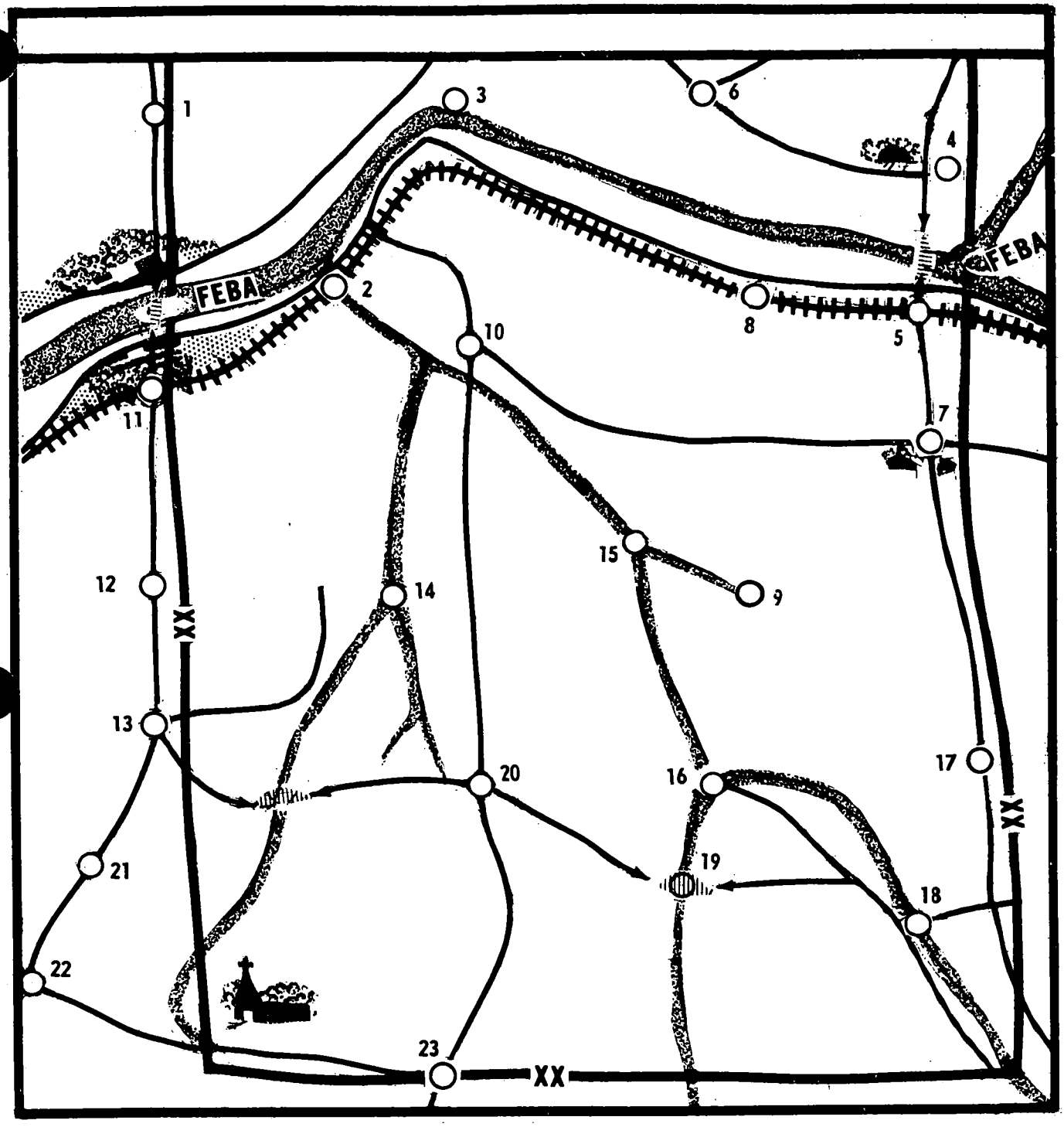


Figure 4–2. Sketch map of division area, showing preselected checkpoints.

(1) The pilot locates the starting checkpoint of a course leg to be flown and either locates the end checkpoint or determines the azimuth of the course leg.

(2) The pilot flies the aircraft on the proper course to pass over the initial checkpoint on a straight path to the end checkpoint. When on course, he alerts the monitor and gives him the height above ground. Shortly before reaching the initial checkpoint, the monitor records the time and height above ground. fore each course leg to assure proper operation.

(3) The pilot commands "Mark" when the aircraft is directly over the starting checkpoint aircraft is directly over the starting checkpoint at which time the monitor reads the survey meter, records the dose rate, and begins timing preselected time intervals.

(4) The monitor reads the survey meter and records the dose rate at each preselected time interval (for example, every 15 seconds).

(5) The pilot again alerts the monitor when the aircraft approaches the end checkpoint. When the aircraft is directly over the end checkpoint, the pilot commands "Mark." At this time the monitor reads and records the final dose rate for the course leg.

d. Procedures for Using Point Technique. Procedures for using the point technique vary according to the situation.

(1) When the situation permits, the aircraft lands near the point of interest and the monitor dismounts, proceeds to the selected point, and takes the reading by using normal ground monitoring procedures.

(2) When the situation does not permit use of the above procedure, an estimation of the ground dose rate may be made by use of an air-ground correlation factor and an aerial dose-rate reading (para 4–11*b*).

4–10. Survey Meter Location in Aircraft

★A specific location for the survey meter in the aircraft must be selected for each aerial survey.

★*a.* The best survey meter locations for several aircraft are given in table 4–1. If the air-ground correlation factors from table 4–2 are to be used, the survey meter MUST be located within the aircraft as specified in table 4–1.

★*b.* When air-ground correlation factor data are to be determined during the survey (para 4–11*a*), the location of the survey meter may be as given in table 4–1, or the location may be selected for the convenience of the pilot and monitor. When aircraft not included in the table are used, such as the OH–58 and AH–1G, the survey meter location must be selected. All dose-rate readings in a survey must be made with the meter in the selected location.

★*Table 4–1. Location of Survey Meter During Aerial Survey*

Aircraft [1]	Survey meter location
OH–6A	Held in front of the left rear seat.[2]
UH–1	In the passenger compartment, held in front of the second seat from the left side of the aircraft.
OH–58A	See paragraph 4–10*b*.
AA–1G	See paragraph 4–10*b*.

[1] Order of preference of currently available aircraft for use in aerial survey is as listed.

[2] This location recommended in the OH–6A aircraft, for which air-ground correlation factors are not available.

4–11. Air-Ground Correlation Factors

An air-ground correlation factor (CF) is required for calculation of ground dose rates from aerial dose rates taken in an aircraft during a survey. The air-ground correlation factor is the ratio of a ground dose-rate reading to a reading taken at approximately the same time in an aircraft at survey height over the same point on the ground. There are two techniques for obtaining the air-ground correlation factor.

★*a.* The preferred technique is by direct determination of ground and aerial dose rates during the survey and subsequent calculation of the air-ground correlation factor. The air-ground correlation factor may be calculated as shown below, using the aerial dose rate taken at survey height and the ground dose rate.

Ground dose rate = 20 rad/hr.

Aerial dose rate (60-meter survey height) = 5 rad/hr

$$\text{Air-ground correlation factor} = \frac{\text{Ground Dose Rate}}{\text{Aerial Dose Rate}}$$

$$= \frac{20 \text{ rad/hr}}{5 \text{ rad/hr}}$$

$$= 4$$

Then, by multiplying the reading taken in the aircraft at a survey height of 60 meters by the air-ground CF, the 1-meter above ground level reading can be estimated. The procedure for determining the ground dose-rate reading involves landing near the selected point. The monitor proceeds to that point and takes the ground dose-rate reading, using normal monitoring procedures. Air-ground correlation factor data are obtained if possible for each two to four course legs or routes flown. The sites for obtaining air-ground correlation factor data should be selected to approximate average foliage and ground surface conditions in the contaminated area. Accuracy of this air-ground correlation factor data as to position, height above ground, and dose rate is of primary importance. New data must be obtained when survey height changes by 15 meters or more, when ground foliage or average ground surface conditions change significantly, if the aircraft or the survey meter is changed, or if weather conditions change drastically during monitoring.

★*b.* When the tactical situation, terrain conditions, high radiation dose rates, or other factors do not permit the use of the preferred technique, the air-ground correlation factors shown in table 4–2 are used (para 4–10*a*). To estimate a ground dose rate, multiply the aerial dose rate obtained by the correlation factor from table 4–2 for the type of aircraft and the height above ground at which the reading was taken. For example, while flying at a 150-meter survey height in a UH–1, a reading of 10 rad/hr is obtained; the air-ground correlation factor for a UH–1 at a height of 150 meters is 8.2.

Ground dose rate = Aerial dose rate × Air-ground CF
= 10 rad/hr × 8.2
= 82 rad/hr

4–12. Capability of Aircraft

Light fixed-wing aircraft or helicopters are satisfactory for conducting aerial surveys; however, because of the slow speeds required (para 4–14*b*(3)), helicopters are the most desirable. Light fixed-wing aircraft and helicopters have approximately the same survey area coverage capability of between 130 and 450 square kilometers per hour per aircraft, depending upon the detail required. Order of preference of currently available aircraft for use in aerial surveys is contained in table 4–1.

★*Table 4–2. Air-Ground Correlation Factors*[1]

Height above ground		Aircraft[2]
Meters	Feet	UH–1
30	100	2.2
60	200	3.2
90	300	4.5
120	400	6.2
150	500	8.2
300[3]	1,000[3]	29.0
600[3]	2,000[3]	300.0
900[3]	3,000[3]	2,600.0

[1] The figures have been rounded to two significant digits for practical use.
[2] Air-ground correlation factors for the OH–6A, OH–58A and AH–1G aircraft are under development.
[3] The use of the air-ground correlation factors with readings taken at these heights results in approximation of ground dose rates.

4–13. Recording and Reporting

a. Recording. The radiological data sheet, designed for recording data obtained by monitoring and survey (para 3–15 and 4–22), will be used for recording data obtained during aerial surveys. Data obtained, using the route or course leg technique, are recorded on the radiological data sheet (DA Form 1971–1–R); data obtained by use of the point technique are recorded on DA Form 1971–R. Headings provided in blocks are self-explanatory; in using the form, any heading not applicable to the situation may be lined through by the monitor. Space is provided for use of the control party, as indicated, for entry of the air-ground correlation factor and normalized readings. The REMARKS block is to be used by the monitor in providing any additional information that will be of value to the control party; this block is also used by the control party to enter time of nuclear burst and computations of the air-ground correlation factor, normalizing factor (para 7–21), and overall correction factor (para 7–22). A completed radiological data sheet, showing data collected by use of the

course leg technique during aerial survey and CBRE calculations, is illustrated in figure 4–3.

b. Reporting. The survey data collected are delivered to the control party at the completion of each aircraft mission by physical drop, radio, or telephone from the nearest landing area. If communications equipment is available, the data may be transmitted by radio directly to the control party as the survey is being conducted.

4–14. Guidance for the Aerial Survey Party

The control party planning the aerial survey may not be completely familiar with the survey area or the current tactical or operational situation that exists there. However, the control party has ready access to the latest information available to the headquarters conducting the survey and provides guidance to the survey party at the briefing. In addition to information about the contaminated area, the control party provides the detailed aerial survey party with the identification of the course legs or routes to be flown, the tentative survey height, and the approximate time periods during which groups of the course legs or routes are to be flown. The control party also may furnish the survey party with the operation exposure guide (chap 6), turn-back dose, and turn-back dose rate (para 4–4).

a. Survey Party Determinations. The aerial survey party determines as applicable:

(1) The actual height above ground at which each course leg or route is to be flown.

(2) The ground speed for each course leg or route.

(3) The direction of flight for each course leg or route.

(4) The locations for determining air-ground correlation factor data.

(5) The time intervals between readings.

(6) Whether to delay the flight of a particular course leg or route.

★*b. Guidance.* As a guide to the survey party in making the determinations in *a* above, the tactical, operational, and weather conditions existing at the time of survey and the dose condition of the survey party should be weighed against the following factors:

(1) The slower the aircraft speed and the shorter the time interval between readings, the more accurate the results.

(2) The unreliability of survey data obtained at heights of more than 150 meters above the ground. A height of 60 meters is considered optimum.

(3) The slow response time of the IM–174A/PD radiacmeter reduces reliability of the data obtained at ground speeds above 53 knots (98 kmph).

(4) The combination of ground speed and reading time interval should be selected so that the ground distance between readings is not more than 500 meters. For increased plotting accuracy, at least 10 readings between checkpoints are desirable.

(5) Air-ground correlation factor data should be taken where aerial and ground dose rates can be read most accurately on the survey meter, for example, in the dose-rate range of 5 to 10 rad/hr.

4–15. Factors Influencing Reliability

★With the guidance and procedures outlined, aerial surveys provide the control party with adequate and sufficiently reliable data. Generally, the dose rate determined by aerial survey varies from the true dose rate at the ground location because of survey meter errors, pilot errors, monitoring errors, erros due to contamination of aircraft at touchdown for ground reading, and the overall system errors.

RADIOLOGICAL DATA SHEET ~~ROUTE TECHNIQUE OR~~ COURSE LEG TECHNIQUE (~~Ground and~~ Aerial Survey) (FM 3-12)	DATE 5 JUNE 1966	PAGE NO. 1	NO. OF PAGES 1
SURVEY PARTY DESIGNATION BRAVO-TWO	MONITOR (Print name) PFC PETER SMITH		
MAP USED GERMANY SHEET 252 1:50,000	AIRCRAFT ~~OR VEHICLE~~ TYPE UH-1		INSTRUMENT TYPE IM-174A/PD

~~ROUTE OR~~ COURSE LEG DESIGNATION	CK-CE	CE-BF		
TIME AT START OF LEG ~~OR ROUTE~~	0950	0955		
~~TIME ROUTE COMPLETED (Ground)~~ OR SURVEY HEIGHT (Air)[1]	60 M	60M		
~~DISTANCE OR~~ TIME INTERVAL USED	10 SEC	10 SEC		

REMARKS

TIME OF BURST - 0730

AIR-Ground CF = 3.8 n = 0.8

CK-CE

NF = 1.96

OCRF = 3.8 × 1.96 = 7.4

CE-BF

NF = 2.01

OCRF = 3.8 × 2.01 = 7.64 = 7.6

READING NO.	DOSE RATE (rad/hr)	DO NOT USE (For control party use only)	READING NO.	DOSE RATE (rad/hr)	DO NOT USE (For control party use only)	READING NO.	DOSE RATE (rad/hr)	DO NOT USE (For control party use only)
1	12	89	1	2	15	1		
2	12	89	2	2	15	2		
3	11	81	3	2	15	3		
4	11	81	4	3	23	4		
5	10	74	5	3	23	5		
6	9	67	6	3	23	6		
7	8	59	7	3	23	7		
8	7	52	8	4	30	8		
9	6	44	9	4	30	9		
10	5	37	10	5	38	10		
11	5	37	11	5	38	11		
12	5	37	12			12		
13	4	30	13			13		
14	4	30	14			14		
15	3	22	15			15		
16	3	22	16			16		
17	2	15	17			17		
18			18			18		
19			19			19		

[1]Times of start and stop are reported for each route or portion of route completed at one time by ground survey. If a route is done in parts, use a separate column for each part.

[2]DO NOT USE. For control party use only.

AIR-GROUND ~~OR VEHICLE~~ CORRELATION FACTOR DATA

LOCATION	HEIGHT (Feet) AIR ONLY	DOSE RATE (rad/hr) ~~INSIDE~~/AIR	DOSE RATE (rad/hr) ~~OUTSIDE~~/GROUND	CF[2]
BF	60M	5	19	3.8

DA FORM 1971-1-R, 1 JAN 63 Replaces DA Form 1971-1-R, 1 Nov 58, which is obsolete.

★*Figure 4–3. Completed radiological data sheet (aerial survey).*

Section III. GROUND RADIOLOGICAL SURVEY

4–16. General

Ground radiological surveys are normally performed by personnel mounted in wheeled or tracked vehicles. The radiological information can also be obtained by personnel on foot but, because of the resultant high radiation doses to personnel, foot surveys should be conducted only under exceptional circumstances. Armored vehicles reduce doses received by personnel and will be used whenever possible. Ground survey lacks the speed and flexibility of aerial survey, results in higher nuclear radiation doses to personnel, places a larger load on communications facilities, and requires diversion of more personnel and equipment from the mission. However, a ground survey is independent of weather conditions, can be conducted at night, and provides more accurate information than an aerial survey. All echelons can perform ground surveys within their areas of responsibility, using regularly assigned personnel and equipment.

4–17. Techniques

The techniques used to conduct ground surveys include: (1) the point technique, (2) the route technique, and (3) the preselected dose-rate technique.

a. Point Technique. In using the point technique, the ground dose rate is determined at a selected point of particular operational concern. The reading can be obtained by dismounting from the vehicle and taking a direct ground dose-rate reading or by taking the dose-rate reading inside the vehicle. From the standpoint of accuracy, the first method is preferred. If the dose rate is taken inside the vehicle, the ground dose rate will be determined by the control party by using a correlation factor (para 4–21). When obtaining readings, while dismounted, monitors should move away from the vehicle a distance of at least 10 meters to make final readings. This procedure prevents undue shielding of the radiation field by the vehicle.

b. Route Technique. In using the route technique, dose-rate readings are taken inside the vehicle at selected distance intervals between check points along a designated route. Ground dose rates will be determined by the control party by using a correlation factor (para 4–21). Most ground surveys are performed by use of the route technique.

c. Preselected Dose-Rate Technique. In using the preselected dose-rate technique, locations of preselected dose rates are determined along assigned routes. This technique is normally employed only for survey of old fallout contamination (after H + 48 hours) or radiological agent contamination where the decay is very slow; dose rates and locations can be plotted directly without further processing.

4–18. Guidance for the Ground Survey Party

Normally, survey parties are briefed prior to conduct of the survey. This briefing may be centralized or conducted on an individual basis and may vary in detail from an area assignment to specific route and point assignments for each survey party. Basically, more general assignments facilitate the initiation of the survey, whereas the more specific assignments reduce security, communication, and interpretation difficulties. The degree of detail of the briefing depends upon the time available to plan the survey, the feasibility of a centralized briefing, and the status of training of survey party personnel.

4–19. Planning

The plan for the ground survey is similar to the aerial survey plan; that is, a series of routes and points are selected along which dose-rate data are obtained. Dose-rate readings are recorded and reported by the monitor of the survey party.

4–20. Survey Meter Location in Vehicles

a. Most dose-rate readings taken during a ground survey by mounted personnel using the route technique will be taken inside the vehicle and later converted to ground dose rates,

using a correlation factor. For operational situations, it is preferred that the correlation factor data be obtained by the survey party for use of the control party in calculating ground dose rates. The survey meter should be located as indicated in figure 4–4. If the vehicle being used is not one of those where the location of the survey meter is designated in figure 4–4, the survey meter should be held in a vertical position (face up) by the monitor who is positioned in the assistant driver's seat. The monitor should take the readings with the survey meter consistently located in the selected position.

b. When correlation factor data cannot be obtained by the survey party, published correlation factors may be used from figure 4–4.

4–21. Correlation Factor Data

a. Requirement. Correlation factor data are required in order to convert the reported readings taken inside the vehicle to ground dose rates existing outside the vehicle.

b. Providing Data. Data for the vehicle correlation factor are provided by the survey party and consist of a set of two readings taken at the same location. One reading is taken inside the vehicle with the instrument located as indicated in paragraph 4–20*a*. All subsequent inside readings reported for the survey must be taken with the meter in this same position. The other reading is taken immediately as a normal ground monitoring reading at the same location with the vehicle pulled away at least 10 meters. One or two additional sets of data should be taken at different locations so that the control party can use an average vehicle correlation factor. The sites for obtaining vehicle correlation factor data should be selected to approximate average foliage and ground surface conditions for the contaminated area. New data must be obtained if these conditions change significantly or if the survey meter or vehicle is changed. Additional correlation factor data taken because of the aforementioned changes should not be averaged into previously collected data, but should be used for applicable routes or points. Accuracy of the correlation factor data is of paramount importance.

4–22. Recording and Reporting

a. Recording. The radiological data sheet (para 4–26), designed for recording data obtained by monitoring and survey (para 3–15), will be used for recording data obtained during ground surveys. Data obtained, using the route technique, are recorded on DA Form 1971–1–R. Data obtained, using the point or preselected dose-rate technique, are recorded on DA Form 1971–R. Instructions for completion are as given in paragraphs 3–15 and 4–13, marking through headings and entering information in the REMARKS block, as appropriate.

b. Reporting. Data from ground surveys are reported from the survey party to the control party of the authority directing the survey as rapidly as possible without screening or evaluation by intermediate headquarters. The reporting is accomplished, using communication methods in the preference order indicated below:

(1) The survey party reports by radio direct to the control party.

(2) The survey party reports by radio to the nearest area communications center and thence to the control party.

(3) The survey party proceeds to the nearest unit and uses its facilities to report through the area communications center to the authority directing the survey.

(4) The survey party proceeds to the nearest area communications center and reports by available means direct to the control party.

(5) The survey party physically delivers data to the control party.

c. Guidance. More precise information on reporting and recording survey data is provided in the unit SOP or is established at the survey party briefing (table 7–1).

d. Security. Radiological survey information is of intelligence value to the enemy. Proper security procedures for the reporting of these data are established by the unit SOP. For example, the unit SOP may require that location coordinates be encoded. The more detailed the briefing of the survey parties, the more easily security can be maintained.

VEHICLES AND STRUCTURES	SURVEY METER LOCATION INSIDE VEHICLE	CORRELATION FACTOR
VEHICLES		
M60 TANK	TURRET–REAR TOP	25
	TURRET–FRONT	53
	CHASSIS–NEAR DRIVER	23
M48A2 TANK	TURRET–REAR TOP	27
	TURRET–REAR BOTTOM	45
	CHASSIS–NEAR DRIVER	45
M113 APC	DIRECTLY IN FRONT OF DRIVER ON FRONT WALL	3.6
	NEAR FIRST SQUAD MEMBER ON LEFT, FACING FORWARD	3.6
M107 SP GUN	NEAR DRIVER, LEFT SIDE	6.0
M108 SP HOW.	NEAR DRIVER, LEFT SIDE	3.6
	REAR, RIGHT SIDE	2.7
M109 SP HOW.	NEAR DRIVER, LEFT SIDE	3.5
	REAR, RIGHT SIDE	3.4
M577 COMMAND POST CARRIER	NEAR DRIVER, RIGHT SIDE	3.2
	REAR, LEFT SIDE	2.5
M551 ARMORED RECON/ABN ASSAULT VEHICLE	NEAR DRIVER, RIGHT SIDE	4.6
M114 RECON VEHICLE	COMMANDER POSITION	2.8
M116 CARGO VEHICLE	PASSENGER POSITION	1.9
M88 RECOVERY VEHICLE	COMMANDER POSITION	6.9
TRUCKS		
* 1/4-TON		1.3
* 3/4-TON		1.7
* 2-1/2-TON		1.7
* 4-TON TO 7-TON		2
STRUCTURES **		
Multistory Building		
UPPER FLOOR		100
LOWER FLOOR		10
Frame House		
FIRST FLOOR		2
BASEMENT		10
Shelter, Underground		
3-FOOT EARTH COVER		5000
FOXHOLES		10

* The survey meter should be held in a vertical position (face up) by the monitor who is positioned in the assistant driver's seat.

** The survey meter should be held in the center of the shelter, 1 meter above the floor.

★*Figure 4–4. Location of survey meter and corresponding correlation factor for residual radiation.*

e. Safety. Precise information establishing turn-back dose rates and operation exposure guide is provided in the SOP or is established at the survey briefing (para 4–4).

4–23. Capability of Ground Survey Parties

Any powered vehicle is satisfactory for conducting ground surveys. All vehicles have approximately the same area coverage capability of between 15 and 40 square kilometers per hour per vehicle, depending upon the degree of detail required, the road net, and trafficability of the contaminated area. However, because of the superior shielding and cross-country characteristics of the tracked armored vehicle, this type of vehicle is preferred.

Section IV. PERSONNEL AND EQUIPMENT REQUIREMENTS

4–24. General

Personnel and equipment for ground survey parties and monitors for aerial survey parties are drawn from the company/troop/battery CBR teams subordinate to the authority directing the survey. Reconnaissance units have the capability (if provided aircraft) of performing aerial or ground surveys as a priority mission when required.

4–25. Personnel Requirements

a. Ground Survey Parties. The number of survey parties required at any one time will depend upon the situation, terrain, time available, detail desired, and other factors.

b. Aerial Survey Parties. The same factors that influence the number of survey parties required for ground surveys are considered in selecting the number of parties required for aerial surveys. *Monitors for the aerial survey parties should be selected from units normally located near an aircraft landing area to reduce the time in getting the survey parties briefed and airborne.* Primary sources for monitors are—

(1) Aerial observers who regularly fly reconnaissance and surveillance missions.

(2) Reconnaissance and armored cavalry-type units.

(3) Other units with trained monitors.

c. Control Parties. Control parties established at all echelons utilize organic personnel.

d. Training. The training of monitors (para 3–7) is applicable to training of survey parties. In addition, survey parties and control parties must receive thorough training in survey techniques and procedures in order to be effective as a team. This training cannot consist merely of instruction but must include frequent practice surveys in field exercises, CPX's, operational readiness training tests, and ATT's. Practice by survey party personnel reduces the time required to obtain and report survey data; practice by control party personnel reduces the time required to process and disseminate the data.

4–26. Equipment Requirements for Survey Parties

a. Instrument for Measuring Dose Rates. The radiacmeter IM–174A/PD (Standard A) or IM–174/PD (Standard B) will be used for measuring dose rates. The IM–141/PDR–27 radiacmeter is more suitable for measuring low dose rates in old contaminated areas.

★*b. Instruments for Measuring Dose.* A dosimeter, such as radiacmeter IM–93()/UD, IM–147/PD (TM 11–6665–214–10), IM–143/PD (USMC), or DT–60/PD (USMC), must be carried for purposes of radiation exposure control (chap 6). The instruments should be properly calibrated before use.

c. Radiological Data Sheet. DA Form 1971–1–R and DA Form 1971–R will be used for recording information collected during the survey. Local reproduction of these forms is authorized.

d. Watch. A watch will be required to determine the time at which survey readings are taken. For aerial survey, a stopwatch or a watch with a sweep-second hand is required to time the interval between readings.

e. Transportation. Vehicles with high radiation shielding characteristics (low transmission

factors–fig. 5–3) should be used for ground surveys. Aircraft should be selected in accordance with the preference order criteria of table 4–1 for aerial surveys.

f. Communications. Communications equipment necessary for accomplishing the reporting procedures specified in paragraph 4–22 is required.

g. Map. Maps of the land areas to be surveyed should be available for the survey party.

CHAPTER 5
OPERATIONAL ASPECTS OF RESIDUAL RADIATION
★(NATO STANAG 2002, CENTO STANAG 2002, SEATO SEASTAG 2002)

Section I. FALLOUT

5-1. General

a. Influence on Operations. Fallout can have a major influence on tactical operations because—

(1) It can produce casualties within very large areas *outside* the area of initial casualty effects of the nuclear burst. It is potentially the most important casualty-producing effect of a nuclear weapon.

(2) It can restrict unprotected troops from vast areas beyond the area of initial casualty effects.

(3) It can increase the logistical problems of affected units. It can limit the unrestricted use of streets, roads, and other communication lines for critical periods. Tremendous engineer and other service efforts are required to decontaminate fallout areas.

(4) It can incapacitate personnel while leaving intact installations and materiel that can be used at a later date.

b. Surface Burst. The surface burst, mainly because of the fallout it produces, is potentially the greatest casualty producer. Depending on the yield of the weapon, the surface burst can produce many times the number of casualties produced by other type bursts. The primary personnel hazard from fallout is whole body gamma radiation.

c. Forecast of Effects. It is necessary, therefore, for commanders to have a means of predicting, in advance of exposure, the anticipated total dose of radiation to be received by personnel who will occupy or pass through a fallout area.

5-2. Decay Calculations

a. Rate of Decay. The rate of decay must be known to perform meaningful dose-rate or dose calculations. This rate of decay is indicated by the decay exponent (n), which may vary with time after burst and location of the contamination within the fallout area. The true decay exponent generally will not be accurately determined until several series of dose-rate readings are available for specific locations within the contaminated area. Therefore, a decay exponent of n equals 1.2 has been established as standard and is used by all units unless informed otherwise by higher headquarters.

b. Decay Nomogram. The decrease in the radiation dose rate from a single explosion can be calculated by the use of a nomogram. The residual radiation decay (fallout) nomogram, figure 5-1, allows the user to find the dose rate at any time if a dose rate at a known time after the burst is available.

Caution: **Figures 5-1 and 5-2 are valid only for single explosions. For multiple-burst fallout see appendix G.**

This nomogram contains 4 lines of 2 scales each which denote time after burst (in hours) for nonstandard decay exponents as indicated above each scale and 1 line (the index scale) which denotes time after burst (in hours) for the standard rate (n = 1.2) of decay. The R_1 scale, at the right of the time scales, shows dose rates at H + 1; R_t scale, at the left of the time scales, shows dose rates at times other than H + 1. The outside left and right lines

are reference lines to be used in alining the hairline. Use of the decay nomogram, involving standard decay (1.2) is shown in the examples below. For use involving decay exponents other than standard, see paragraphs 5–8 and 5–9.

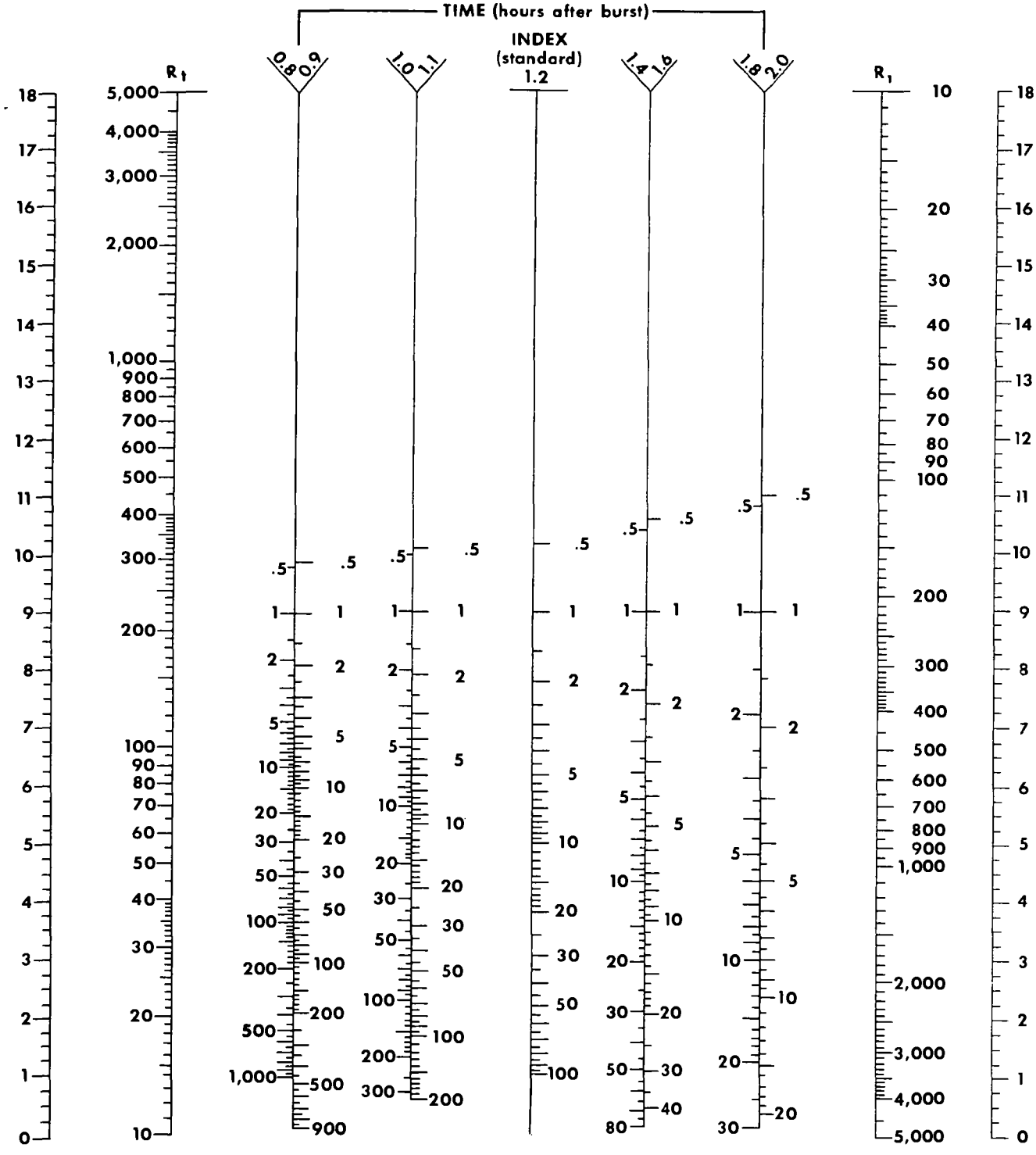


Figure 5–1. Residual radiation decay (fallout).

c. Example Problems. In working with nomograms, care should be taken to be as consistent as possible when joining values with the hairline. Be sure that the hairline intersects the vertical line and the interpolated value (tickmark) as closely as possible. Dose-rate values smaller or greater than those shown on the nomogram in figure 5-1 may be reported. In the case of *smaller* values, *multiply* the dose rate by 10, proceed with the calculation, and divide the resulting dose rate by 10 (see example problem 4). In the case of *greater* values, *divide* the dose rate by 10, proceed with the calculation, and multiply the resulting dose rate by 10. When using this process, *NEVER* multiply or divide a number from the time scale; multiply or divide, as appropriate, using only the dose-rate values (see example problem 5).

(1) *Example problem 1.*
GIVEN. R_t = 200 rad/hr at H + 5 hours.
FIND. R_1.
ANSWER. 1,350 rad/hr.
SOLUTION. Aline the hairline with the 5-hour tickmark of the 1.2 (index) scale and the 200 rad/hr point on the R_t scale. Read the dose rate at H + 1 as 1,350 rad/hour at the point of intersection of the hairline with the R_1 scale.

(2) *Example problem 2.*
GIVEN. R_1 = 1,000 rad/hr.
FIND. R_t at H + 6 hours.
ANSWER. 120 rad/hr.
SOLUTION. Aline the hairline with the 6-hour tickmark of the index scale and the 1,000 rad/hr point on the R_1 scale. Read R_t as 120 rad/hr at the point of intersection of the hairline with the R_t scale.

(3) *Example problem 3.*
GIVEN. R_1 = 1,000 rad/hr.
FIND. Time when R_t = 700 rad/hr.
ANSWER. H + 1.4 hours.
SOLUTION. Connect 1,000 rad/hr on the R_1 scale and 700 rad/hr on the R_t scale with the hairline. Read time as H + 1.4 hours at the point of intersection of the hairline and the index scale.

(4) *Example problem 4.*
GIVEN. R_1 = 200 rad/hr.
FIND. R_t at H + 25 hours.
ANSWER. 4.4 rad/hr.
SOLUTION. Connect 2,000 rad/hr (10 × 200 rad/hr) on the R_1 scale and 25 on the index (time) scale with the hairline. Read R_t as 44 rad/hr on the R_t scale. *Divide* this dose rate by 10 since the R_1 value was multiplied by 10; then, the dose rate at H + 25 hours is 4.4 rad/hr.

(5) *Example problem 5.*
GIVEN. R_1 = 200 rad/hr.
FIND. Time when R_t = 4 rad/hr.
ANSWER. H + 27 hours.
SOLUTION. Since 4 rad/hr cannot be found on the R_t scale, multiply both R_1 and R_t by 10; connect R_1 = 2,000 rad/hr and R_t = 40 rad/hr with the hairline. Read t as H + 27 hours on the time scale. DO NOT divide the time by 10 (*c* above).

5-3. Total Dose Predictions

a. General. The dose rate of radiation does not directly determine whether or not personnel become casualties. Casualties are dependent on total dose received. If the dose rate were constant, total dose would simply be the product of dose rate and time in the contaminated area, just as in a road-movement problem rate x time = distance. But the dose rate is continually diminishing because of decay; hence, the calculation is a little more complicated. The actual dose received is always *less* than the product of dose rate at time of entry and duration of stay (see *e* below for estimates made after H + 24 hours).

b. Total Dose Calculations. The nomogram in figure 5-2 is used for predicting total dose to be received while operating in a fallout radiation area resulting from a single explosion. This nomogram relates total dose, dose rate referenced to 1 hour after the burst, stay time, and entry time. The index scale is a pivoting line that is used as an intermediate

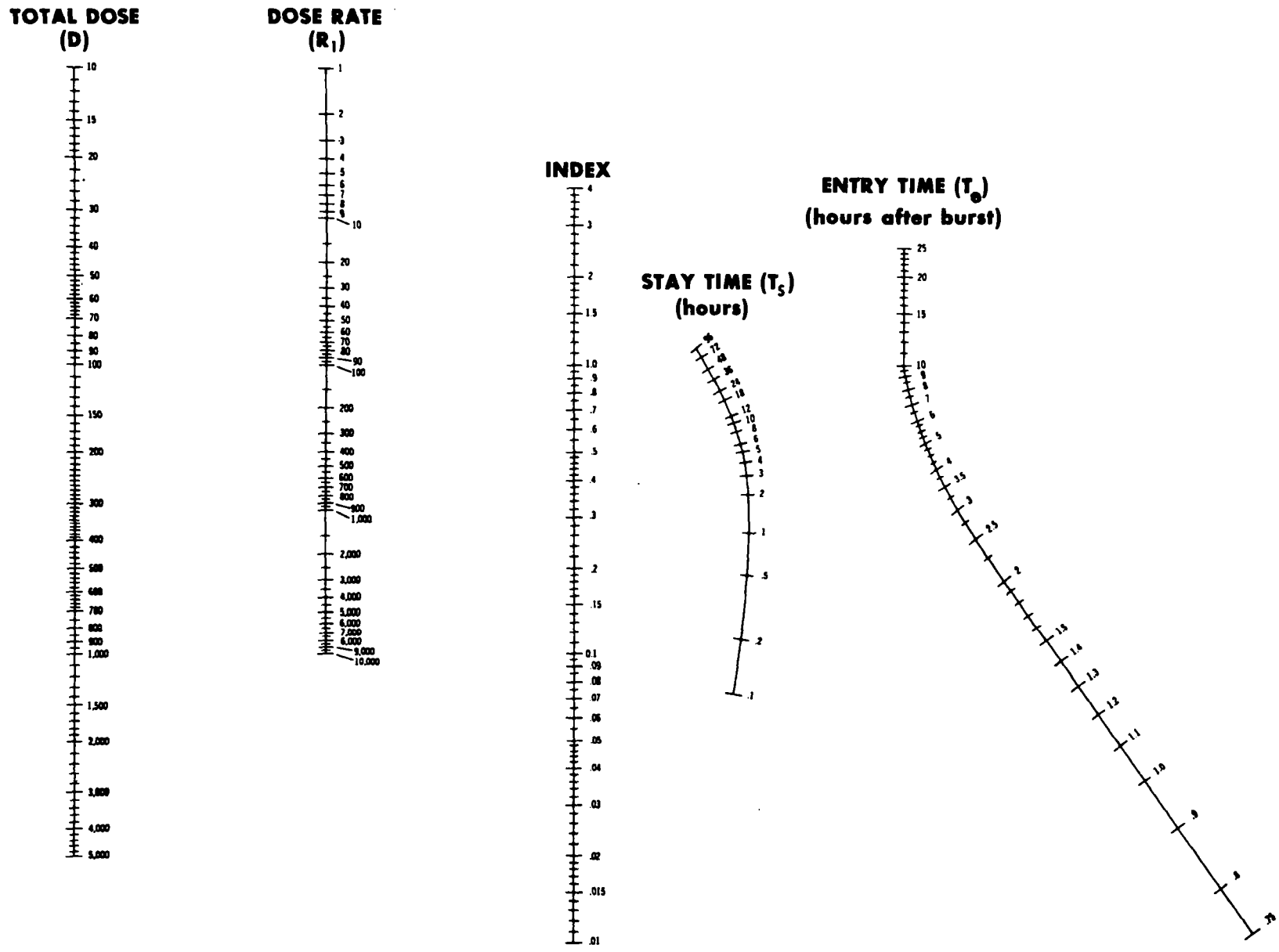


Figure 5–2. Total dose (fallout).

step between D and R_1 and T_s and T_e. The four values on this nomogram are defined as follows:

D = total dose in rad.
R_1 = dose rate 1 hour after burst (H + 1). When using this nomogram, a dose rate referenced to 1 hour after the burst (H + 1) must ALWAYS be used; NEVER use a dose rate taken at any other time. See *c* below.
T_s = stay time in hours.
T_e = entry time (hours after burst).

Any one of these values may be determined from the nomogram if the other three values are known, as shown in examples of *d* below.

c. Essential Information.

(1) If the available dose rate was taken at a time other than H + 1 hour, the value of R_1 may be found by using the residual radiation decay (fallout) nomogram (fig. 5–1) and the procedures of paragraph 5–2.

(2) In applying the given values, D and R_1 are used together and T_s and T_e are used together. When working with the total dose nomogram, always start the problem on the side of the nomogram for which two values are known. If D and R_1 are given, start with these two known values; if T_e and T_s are given, start with them. Never begin a problem by joining D or R_1 with either of the time values.

d. Example Problems.

(1) *Example problem 1.*

GIVEN. R_1 = 200 rad/hr.
T_e = H + 1.5 hours.
T_s = 1 hour.
FIND. D
ANSWER. 90 rad.
SOLUTION. On figure 5–2, connect H + 1.5 hours on the T_e scale and 1 hour on the T_s scale with the hairline. Pivot the hairline at its point of intersection with the index scale to 200 rad/hr on the dose rate (R_1) scale. Read D = 90 rad on the total dose (D) scale.

(2) *Example problem 2.*

GIVEN. D = 20 rad.
R_1 = 100 rad/hr.
T_s = 1 hour.
FIND. T_e.
ANSWER. H + 3.4 hours.
SOLUTION. On figure 5–2, connect 20 rad on the D scale and 100 rad/hr on the R_1 scale with the hairline. Pivot the hairline at its point of intersection with the index scale to 1 hour on the T_s scale. Read T_e = 3.4 hours on the T_e scale.

e. Calculations When Time of Entry is After H + 24 Hours. By 24 hours after burst, the change in the rate of decay is so low that it is relatively insignificant. Therefore, in making estimates of the total dose to be received when entry into the contaminated area is later than H + 24 hours, the total dose is obtained by multiplying the dose rate at entry time by the stay time (in hours). Symbolically, this is written—

$D = R_{Te} \times T_s$, where:
D = total dose,
R_{Te} = dose rate of entry, and
T_s = time of stay.

5–4. Validity

The calculations above and the nomograms in figures 5–1 and 5–2 are valid only if the dose-rate reading is made after the radioactive particles have ceased falling. For example, a dose-rate reading made 1 hour after the burst while fallout is still arriving is not valid for determining what the dose rate will be at a later time since there is no way to determine how much more fallout will arrive.

Caution: **Figures 5–1 and 5–2 are valid only for single explosions. For multiple-burst fallout see appendix G.**

5–5. Transmission Factor

a. General. A transmission factor (TF) is used to determine the reduction in the dose received when personnel are protected (shielded) from radiation (para 1–8). Transmission factors for residual radiation have been established for certain shielding environments and are given in figure 5–3. These

ENVIRONMENTAL SHIELDING	TRANSMISSION FACTOR
VEHICLES	
M60 TANK	0.04
M48A2 TANK	0.02
M41 TANK	0.1
M113 APC	0.3
XM 104 SP HOW.	0.5
M107 SP GUN	0.4
M108 SP HOW.	0.3
M109 5P HOW.	0.2
M110 SP HOW.	0.4
XM106 SP MORTAR	0.3
M125A SP MORTAR	0.3
M114 RECON VEHICLE	0.3
M116 CARGO VEHICLE	0.6
M548 CARGO VEHICLE	0.7
M88 RECOVERY VEHICLE	0.09
M578 RECOVERY VEHICLE	0.3
M577 COMMAND POST CARRIER	0.3
M551 ARMORED RECON/ABN ASSAULT VEHICLE	0.2
M728 COMBAT ENGR VEHICLE	0.04
TRUCKS	
1/4-TON	0.8
3/4-TON	0.6
2-1/2-TON	0.6
4-TON TO 7-TON	0.5
STRUCTURES	
Multistory Building	
UPPER FLOOR	0.01
LOWER FLOOR	0.1
Frame House	
FIRST FLOOR	0.6
BASEMENT	0.1
URBAN AREA (In Open)	0.7*
WOODS	0.8*
SHELTER, UNDERGROUND (3-foot eorth cover)	0.0002
FOXHOLE5	0.1

*These factors do not apply to ground survey dose rotes.

★*Figure 5–3. Transmission factors for residual radiation.*

transmission factors may be used in determinations of shielded dose rate or total dose.

Note. It is pointed out that these transmission factors are not necessarily the inverse of the correlation factors for the same vehicle listed in figure 4–4. Generally, the correlation factors in figure 4–4 were calculated using the best position for the survey meter to give readings for radiological survey data. The transmission factors in figure 5–3 were calculated to indicate the shielding afforded by vehicles to personnel in the vehicles. Also, these transmission factors may vary from other published transmission factor data (for example, the data on the ABC–M1 calculator; see paragraph 5–7*b*). The transmission factors used in this manual are preferred over those on the back of the ABC–M1 calculator.

b. Determination of Transmission Factors. Transmission factors for common types of vehicles, structures, or fortifications are contained in figure 5–3. These transmission factors were established, in the case of a combat vehicle, by determining the shielded dose or dose rate for the most exposed occupant location and, in the case of a structure or fortification, by determining the shielded dose or dose rate at approximately the center of the shielded volume. Transmission factors determined in the field require two dose-rate readings taken about the same time; one will be an outside (ground) dose-rate (OD) reading and the other an inside (shielded) dose-rate (ID) reading. The transmission factor can then be calculated using the formula below:

$$\text{Transmission factor} = \frac{\text{Inside dose or dose rate}}{\text{Outside dose or dose rate}} \text{ or } TF = \frac{ID}{OD};$$

and, by mathematical rearrangement: $ID = TF \times OD$ and $OD = \frac{ID}{TF}$.

Example problem:

What is the calculated transmission factor of a bunker when the outside dose rate is 200 rad/hr and the inside dose rate is 25 rad/hr.

ANSWER. 0.125

$$\text{SOLUTION. } TF = \frac{ID}{OD} = \frac{25}{200} = 0.125$$

c. Examples.

(1) In example problem 1 (para 5–3*d* (1)), the outside dose (OD) as calculated from the nomogram was 90 rad. The inside dose (ID) is calculated by use of a transmission factor. What dose would troops in M113 armored carriers receive? The TF for an M113 armored carrier is 0.3 (fig. 5–3).

$$ID = OD \times TF$$
$$= 90 \times 0.3$$
$$= 27 \text{ rad.}$$

(2) Transmission factors may also be applied to dose rates. A measured outside dose rate is 100 rad/hr. The inside dose rate is calculated by use of the transmission factor. Find the dose rate inside the M113 carrier.

$$ID = OD \times TF$$
$$= 100 \times 0.3$$
$$= 30 \text{ rad/hr.}$$

5–6. Crossing a Fallout Area

a. General. It may be necessary to cross an area in which there is residual radiation. This occasion might arise in exploitation of our own surface bursts or in retrograde or offensive operations coupled with enemy-delivered surface bursts. In nuclear warfare it is possible that extensive areas will be made residually radioactive. These areas will be habitable eventually, but operations in these areas will be complicated because of the necessity for keeping to a minimum the total dose that will be received by our troops.

★*b. Commander's Questions.* The problem of crossing a contaminated area, from a command point of view, is essentially "if I cross the area, what is the risk involved?" In general, the primary objective is to accomplish the desired mission while keeping the total dose as low as possible consistent with the mission. Exposure may be minimized by keeping the stay time as short as possible, by delaying the entry time as long as possible, by providing shielding, and by avoiding the contaminated area. The selection of one, or any combination of, these actions is dependent upon the operational situation at the time and knowledge of the location and extent of dose-rate contours within the fallout area. A consideration of the radiation exposure involved will influence route selection. The shortest route, or the route that can be traversed

most quickly, provides the minimum stay time. If possible, routes through areas of lowest dose rates should be selected. The use of tanks, armored vehicles, or sandbags on the floors and sides of cargo trucks will provide shielding and reduce the total dose received by personnel.

c. Average Dose Rate. In analyzing the problem of crossing a contaminated area, it is evident that the dose rate will increase as the center of the area is approached then will decrease beyond the center of the area and as the far side is approached. When individuals or units are required to cross a contaminated area, it is necessary to determine an average dose rate to be used in predictions of total dose. The average dose rate represents a mean value to which the individual is exposed during the time of stay. A reasonable approximation of the average dose rate (R_{avg}) in crossing a fallout area can be obtained by dividing the maximum dose rate (R_{max}) encountered, or expected to be encountered, by two. Symbolically, this is written as $R_{avg} = \frac{2}{R_{max}}$.

d. Procedures. After the average dose rate has been determined entry times that will keep the total dose below a specified maximum (operation exposure guide) can be computed on the basis of calculated stay times; or total doses can be computed for specified entry times and stay times. These calculations are made in the manner described below.

e. Calculations.

(1) In calculating the total dose to be received in crossing a fallout area, it is necessary to know the time of entry into the area, the average dose rate along the route, and the time of stay within the area. Use the total dose (fallout) nomogram in figure 5–2 and the methods of paragraph 5–3 for these calculations.

(2) In crossing the average dose rate is equal to one-half the maximum dose rate encountered on the route (*c* above). If the maximum dose rate encountered is 60 rad/hr, then,

$$R_{avg} = \tfrac{1}{2} R_{max}$$
$$= \tfrac{1}{2} \times 60 \text{ rad/hr}$$
$$= 30 \text{ rad/hr}$$

(3) In using figure 5–2, the average dose rate must be normalized (taken back) to H + 1. Refer to paragraph 5-2*b* and *c* for determining dose rate at H + 1 by using figure 5–1.

(4) In calculating the total dose to be received when crossing a fallout area, follow the procedure below.

(*a*) Calculate the average dose rate.

$$R_{avg} = \tfrac{1}{2} R_{max}.$$

(*b*) Normalize R_{avg} to H + 1, unless the dose rate data have already been referenced to H + 1.

★(*c*) Calculate the time required to cross the fallout area. The length of the route within the 20 rad/hr (H + 1) contour line is the disance used.

$$T_s = \frac{\text{distance}}{\text{speed}}.$$

(*d*) Find the outside dose, using figure 5–2.

(*e*) Calculate the inside dose; if shielding is involved, obtain TF from figure 5–3.

$$ID = OD \times TF.$$

f. Example Problems The following problems are concerned with techniques only and do not consider the impact that these doses or dose rates might have on operations in a contaminated area.

(1) *Example problem 1.*

GIVEN. Troops are to cross the fallout area shown in figure 5–4 at H + 3 in M113 armored personnel carriers at a rate of speed of 10 kilometers per hour (kmph). The route from A to B, a distance of 5 kilometers (km), will be used.

FIND. Total dose that will be received by troops.

ANSWER. 5.4 rad.

SOLUTION.

(*a*) Calculate the average dose rate.

$R_{avg} = \frac{1}{2} R_{max}$
$= \frac{1}{2}$ (300 rad/hr)
$= 150$ rad/hr (at H + 1).

(*b*) Normalize R_{avg} to H + 1. R_{avg} is already at H + 1.

(*c*) Calculate the time of stay.

$$T_s = \frac{\text{distance}}{\text{speed}}$$
$$= \frac{5 \text{ km}}{10 \text{ kmph}}$$
$= 0.5$ hour.

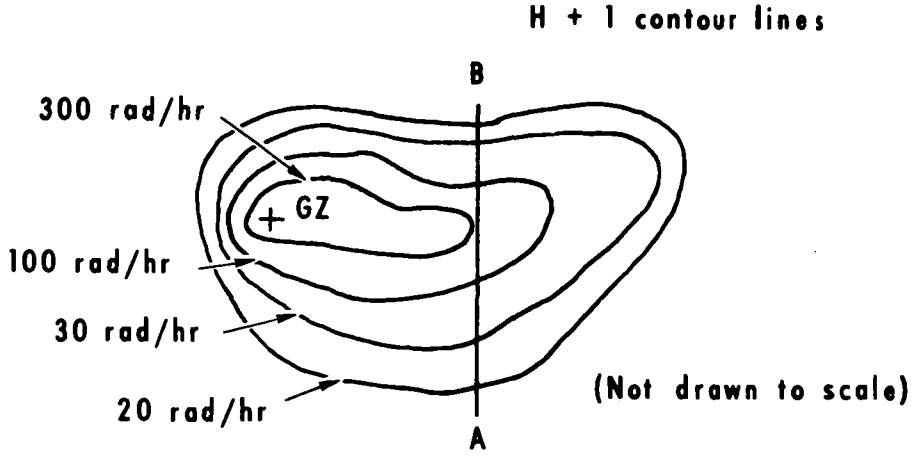
(*d*) Find the outside dose, using figure 5-2.

$R_{avg} = 150$ rad/hr
$T_o = H + 3$ hours.
$T_a = 0.5$ hour.
$D = 18$ rad.

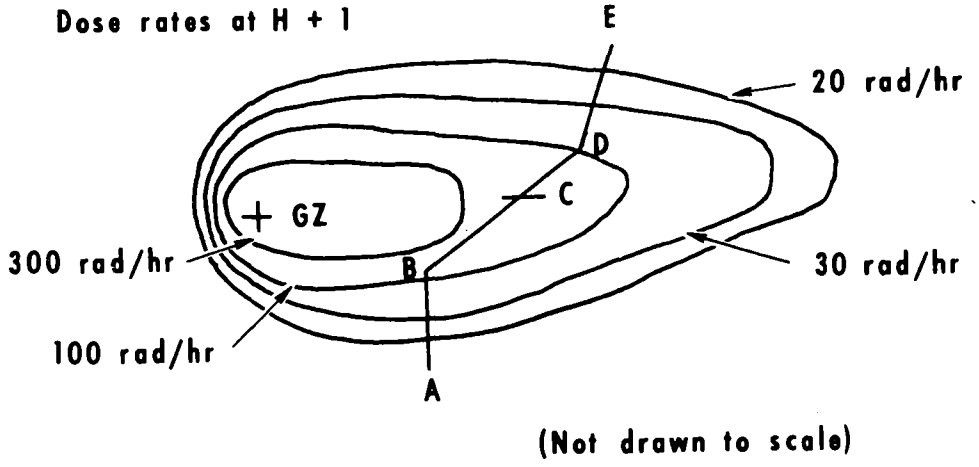
(*e*) Calculate the inside dose.

TF $= 0.3$ (fig. 5-3).
ID $= OD \times TF$
$= 18 \times 0.3$
$= 5.4$ rad.

(2) *Example problem 2.*



★*Figure 5-4. Crossing a fallout area, example problem 1.*



★*Figure 5-5. Crossing a fallout area, example problem 2.*

GIVEN. Troops are to cross the fallout area shown in figure 5–5 at H + 3 in 2½-ton trucks moving at 15 kmph, using the route A–B–C–D–E. Total distance = 7.5 km.

FIND. Total dose that will be received by troops.

ANSWER. 7.2 rad.

SOLUTION.

(*a*) Calculate the average dose rate.

$R_{avg} = \frac{1}{2} R_{max}$

$= \frac{1}{2}$ (200 rad/hr, estimated between the 100 and 300 rad/hr line).

$= 100$ rad/hr (at H + 1).

(*b*) Normalize R_{avg} to H + 1. R_{avg} is already at H + 1.

(*c*) Calculate the time of stay.

$$T_s = \frac{\text{distance}}{\text{speed}}$$

$$= \frac{7.5 \text{ km}}{15 \text{ kmph}}$$

$= 0.5$ hour.

(*d*) Find the outside dose, using figure 5–2.

$R_{avg} = 100$ rad/hr.
$T_o = H + 3$ hours.
$T_s = 0.5$ hour.
$D = 12$ rad.

(*e*) Calculate the inside dose.

$TF = 0.6$ (fig. 5–3).

$ID = OD \times TF$

$= 12 \times 0.6$

$= 7.2$ rad.

5–7. Radiac Calculator

★*a. General.* The ABC–M1 radiac calculator, a component of the M28A1 nuclear calculator set, is designed to provide a rapid means of performing calculations similar to those described in this section when the decay exponent is standard (n = 1.2). Problems involving decay, normalizing, dose, dose rate, time of stay, time of exit, and determination of H-hour (para 7–19) can be solved with this calculator.

b. Description and Use. TB CML 92 describes the ABC–M1 radiac calculator and illustrates its use with detailed example problems.

Note. The transmission factors on the back of the calculator do not agree in all cases with those published in this manual. The transmission factors from figure 5–3 should be used if discrepancies exist.

Section II. NONSTANDARD DECAY OF FALLOUT

5–8. General

a. Explanation. To define nonstandard decay, standard decay must first be defined. The calculations in paragraphs 5–1 through 5–7 are based on the equation $R_t = R_1 t^{-1.2}$, where 1.2 is the standard value of the decay exponent (n). Decay is standard when the actual dose rates from fallout do not differ significantly from those predicted by this equation. Decay is nonstandard when the actual dose rates from fallout *do differ* significantly from those predicted by the above equation.

b. Factors Affecting Decay Rate. The factors that affect the rate of decay of fallout may be divided into several broad groups as follows:

(1) The type of weapon and type of active materials, along with the construction and structural materials, in the weapon.

(2) The type and quantity of materials vaporized and sucked up into the fireball.

(3) The use of radiological agents which produce nonstandard decay.

(4) Fallout on fallout. When new fallout overlaps a fallout contaminated area, this area will usually have a nonstandard decay rate varying from location to location (app G).

c. Decay Rate Determinations. Nonstandard decay-rate determinations will be performed by the CBRE of the TOC of major commands. When the CBRE has determined from actual monitoring data that the decay rate is nonstandard, the information will be disseminated by the TOC of the major command. A unit op-

erating in the field will always assume the decay is standard unless informed otherwise. The procedures used by the CBRE to determine decay exponents (n) are explained in paragraphs 7–16 through 7–22 or, in the case of fallout on fallout, in appendix G.

5–9. Calculations

a. Nonstandard Decay Dose-Rate Calculations. Dose-rate calculations in areas of nonstandard decay can be made, using the residual radiation decay (fallout) nomogram of figure 5–1. In using this nomogram for decay exponents other than standard (1.2), the times from the various decay exponent scales must *always* be projected to the index scale before pivoting. The following examples explain the use of the nomogram for decay exponents other than standard.

(1) *Example problem 1.*

GIVEN. $R_1 = 100$ rad/hr.
$n = 0.8$.
FIND. R_t at H + 7 hours.
ANSWER. 20 rad/hr.

SOLUTION. Using figure 5–1, aline the hairline with 7-hour tickmark of the 0.8 time scale and equal values of the left and right reference lines. Mark a point on the index scale where the hairline intersects it. Then pivot the hairline about this point to the 100 rad/hr tickmark on the R_1 scale. Read the dose rate at H + 7 as 20 rad/hr at the point of intersection of the hairline with R_t scale.

(2) *Example problem 2.*

GIVEN. $R_1 = 2{,}000$ rad/hr.
$R_t = 45$ rad/hr.
$n = 2.0$.
FIND. The time at which the dose rate will be reduced to 45 rad/hr.
ANSWER. H + 7.

SOLUTION. Using figure 5–1, aline the hairline with 45 rad/hr on the R_t scale and 2,000 rad/hr on the R_1 scale. At the intersection of the hairline with the index scale, pivot (holding

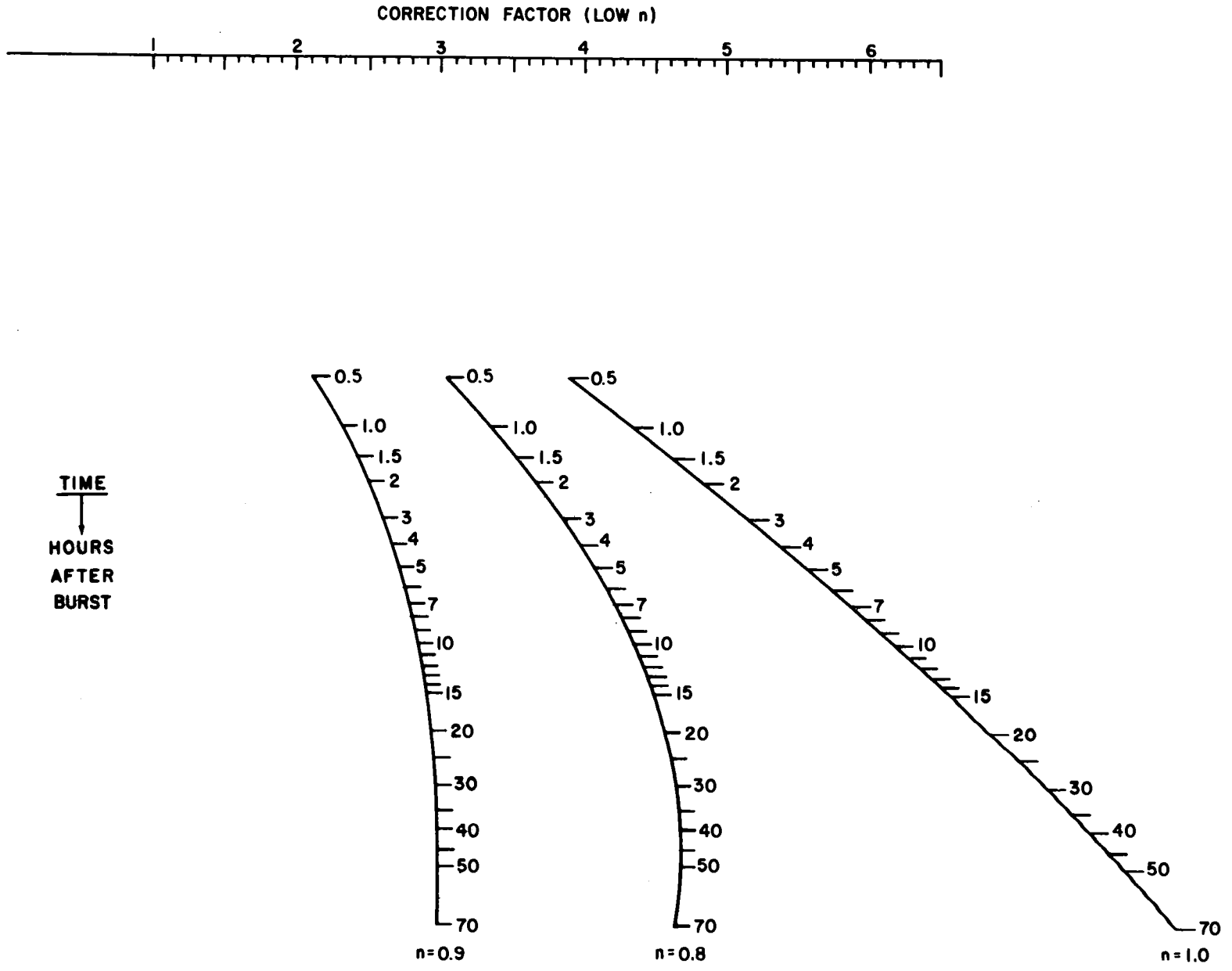


Figure 5–6. Correction factor for nonstandard decay (LOW n).

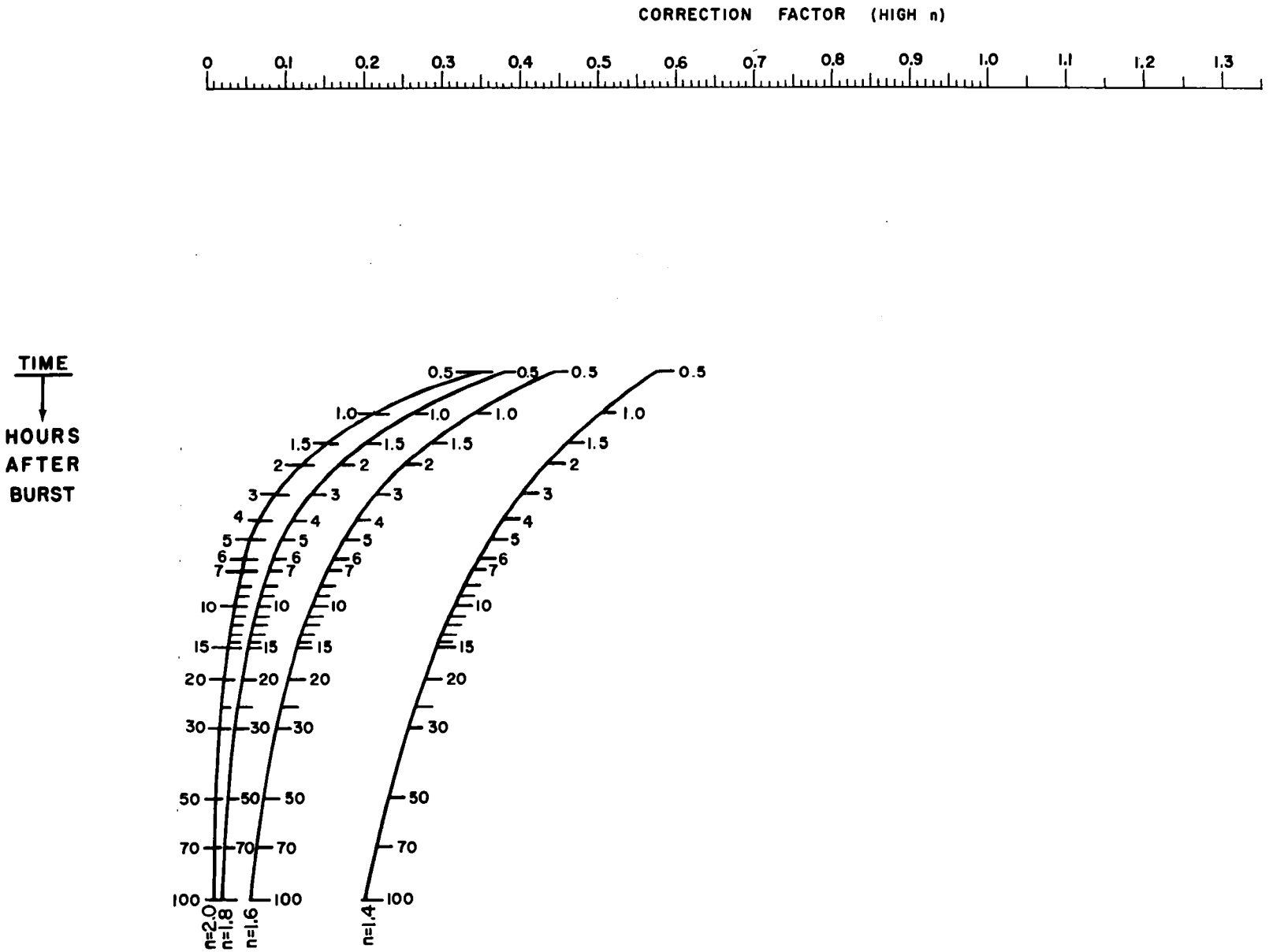


Figure 5–7. Correction factor for nonstandard decay (HIGH n).

a sharp object at the intersection) and aline equal values on the left and right reference lines. Read 7 hours at the point of intersection of the hairline with the 2.0 time scale.

b. Total Dose Calculations. Total dose calculations for operations conducted in contaminated areas where the decay rate is *nonstandard* are made, using the following procedures:

(1) A dose calculation is made, using the total dose (fallout) nomogram (fig. 5–2) and the procedures outlined in paragraph 5–3.

Note. The R_1 value *must always* be determined for dose calculations by using the appropriate decay exponent.

★(2) A correction factor (CRF) is determined from figure 5–6 or 5–7, depending upon the decay exponent. Figures 5–6 and 5–7 are nomograms showing the relationship of CRF, n, T_e, and time of exit (T_x) where $T_x = T_e + T_s$. The time after burst (T_e and T_x) is scaled along the curve for each decay exponent. Figure 5–6 gives the correction factor for decay exponents below standard and figure 5–7 gives the correction factor for decay exponents above standard. The correction factor is found by placing the hairline on the time-after-burst curve for the known decay exponent so that it passes through (connects) time of entry and time of exit. The correction factor is then read at the point of intersection of the hairline with the correction factor scale. Use of these nomograms is included in examples in *c* below.

(3) The true dose can be determined by multiplying the dose calculated from figure 5–2 by the correction factor determined from the appropriate nomogram for the known decay exponent. Symbolically, this is written:

$$D_t = D_s \times CRF,$$

where:

D_t = true dose,
D_s = calculated dose, using standard decay, and
CRF = correction factor, dependent upon the true decay rate.

Note. For problems where it is desired to find a time of entry or a time of stay such that a specific total dose will not be exceeded, standard decay should be assumed. These calculations are approximations, since no direct method is available for finding these values for nonstandard decay.

c. Example Problems. The following example problems explain the use of the procedures outlined in *b* above; they do not consider the impact that the dose or dose rates might have on operations in a contaminated area.

(1) *Example problem 1.*

★GIVEN. R_t = 190 rad/hr at H + 2 hours.
T_e = H + 2 hours.
T_s = 8 hours.
n = 0.9.

FIND. True dose to be received by personnel while staying in a contaminated area.

ANSWER. 656 rad.

SOLUTION. The dose rate at H + 2 must be normalized to H + 1. This is done by using figure 5–1 in the manner described in paragraph 5–2; read a value of 350 rad/hr from figure 5–1. On figure 5–2, using a R_1 value of 350 rad/hr with the given values of T_e (H + 2) and T_s (8 hours), read a calculated dose of 410 rad. Find the correction factor from figure 5–6, using the decay exponent of 0.9; place the hairline so that it passes through 2 hours (T_e) and 10 hours (T_x) on the 0.9 time-after-burst curve (n = 0.9). Read a correction factor of 1.6 where the hairline intersects the correction factor scale (*b* (2) above). Find the true dose by multiplying the calculated dose by the correction factor.

Thus:

$$D_t = D_s \times CRF$$
$$= 410 \text{ rad} \times 1.6$$
$$= 656 \text{ rad.}$$

(2) *Example problem 2.*

GIVEN. D_s = 200 rad.
T_e = H + 3 hours.
T_s = 4 hours.
n = 1.8.

FIND. True dose to be received by personnel while staying in a contaminated area.

ANSWER. 82 rad.

SOLUTION. Find the correction factor from figure 5–7, using the decay exponent of 1.8; place the hairline so that it passes through 3 hours (T_e) and 7 hours (T_x) on the time-after-burst curve (n = 1.8). Read the correction factor of 0.41 where the hairline intersects the correction factor scale. Thus:

$$D_t = D_s \times CRF$$
$$= 200 \times 0.41$$
$$= 82 \text{ rad.}$$

Section III. INDUCED RADIATION

5–10. Nature of Induced Radiation

Neutrons are produced in all nuclear weapon detonations. Some of these neutrons may be captured by the various elements in the soil under the burst. As a result of neutron capture, some of these elements become radioactive, generally emitting beta particles and gamma radiation for an extended period of time following an explosion. Beta particles are a negligible hazard unless the radioactive material makes direct contact with the skin for an extended period of time. In this case, the beta particles can cause skin irritations varying from reddening to open sores. In contrast, gamma radiation readily penetrates the body and can cause radiation injury and even death. Consequently, the external military hazard of induced radiation is determined substantially through an analysis of the dose rate of the emitted gamma radiation.

5–11. Characteristics of Induced Radiation

The principal characteristics of induced radiation are—

a. Localized Symmetrical Pattern. The pattern of induced radiation is circular around ground zero. The dose rates within the pattern are highest at ground zero and decrease with distance from ground zero. The pattern is much smaller than the fallout pattern would be if the same weapon were burst on the surface. Weather conditions have no influence on the location and size of the pattern or the dose rate of induced radiation, and there is no shifting of the pattern by surface winds. The pattern, if produced, will always be located around ground zero. See paragraph 5–13 for a discussion of the relationship between induced radiation and soil composition.

b. Difficult to Decontaminate. Since the soil in the target area is made radioactive to a depth of about 0.5 meter, decontamination is difficult, requiring the removal of the top 10 centimeters of soil where most of the radiation exists. In contrast, fallout is a deposit of radioactive dust on the surface and can be removed with somewhat more ease than induced radiation. Both types can be covered by earth.

c. Persistent. The decay characteristics of induced radiation are considerably different from those of fallout. Fallout is a mixture of many different substances, all with different rates of decay. Induced radiation is produced primarily in aluminum, manganese, and sodium. Other elements either emit so little gamma radiation or decay so fast that they are less important. During the first one-half hour after a burst, the principal contributor to induced radiation is radioactive aluminum. Almost all soils contain aluminum since it is one of the most abundant elements. Radioactive aluminum has a short half-life, so that within one-half hour after burst almost all the radioactive aluminum has decayed. Most soils also contain significant quantities of manganese which decays with a half-life of about 2.6 hours. From one-half hour after burst until 10 to 20 hours after burst, both manganese and sodium are the principal contributors to the radiation. After 10 to 20 hours, sodium, which decays with a half-life of about 15 hours, is the principal source of radiation.

5–12. Considerations of the Operational Level

a. General. A commander will desire to expose his unit to as little radiation as is compatible with the military situation. The commander may know the approximate ground zero of recent or planned nuclear detonations and will select, if possible, a course of action that will avoid the expected areas of induced radiation. However, enemy action, obstacles, or the attainment of significant tactical ad-

vantage may cause a commander to move his unit through an area of induced radiation. Also, a radiologically contaminated area may be encountered unexpectedly. The following is a discussion of aids available to the commander and some suggested courses of action.

b. Aids to the Commander.

(1) *Boundary and extent of area.* The boundary of the significant area of induced activity is considered to be the distance to which a 2 rad/hr dose rate 1 hour after burst will extend. The maximum horizontal radius of this dose-rate contour for yields of 1 MT or less at times later than 1 hour after burst is about 1,400 meters; it is usually substantially less, depending on the yield and height of burst of the weapon.

(2) *Indications of ground zero direction.* The circular symmetry of some types of damage such as scorching, tree blowdown, or other blast phenomena may be visible. In addition, the reverse sides of objects or shadowed objects normally will not be burned. Since the severity of these damage patterns increases in the direction of ground zero, examination of the damage may reveal the direction of ground zero.

(3) *Radiological monitoring.* Radiological monitors should habitually accompany the lead elements and continuously monitor the route of advance. Information obtained by these monitors can be used to determine if radiation has been encountered, how the dose rate increases with direction of travel, and whether the maximum dose-rate point has been passed for any route selected through the area of radiation.

c. Courses of Action.

(1) *Selecting a route.* Any route, whether a straight line or a peripheral course, that avoids the area in the vicinity of ground zero will reduce doses below those from a route which passes through or near ground zero. However, this option as to route selection may be influenced by the terrain. Obstacles formed by tree blowdown, fires, and building collapse may limit not only the number of routes available but also the mode of movement, that is, on foot or in vehicles.

(2) *Mode of crossing.* If there is an option as to the method of transportation to be used in crossing an area of induced activity, it should be selected in the following priority:

(*a*) Armored vehicles and personnel carries.

(*b*) Wheeled and tracked vehicles, preferably with sandbagged floors and sides.

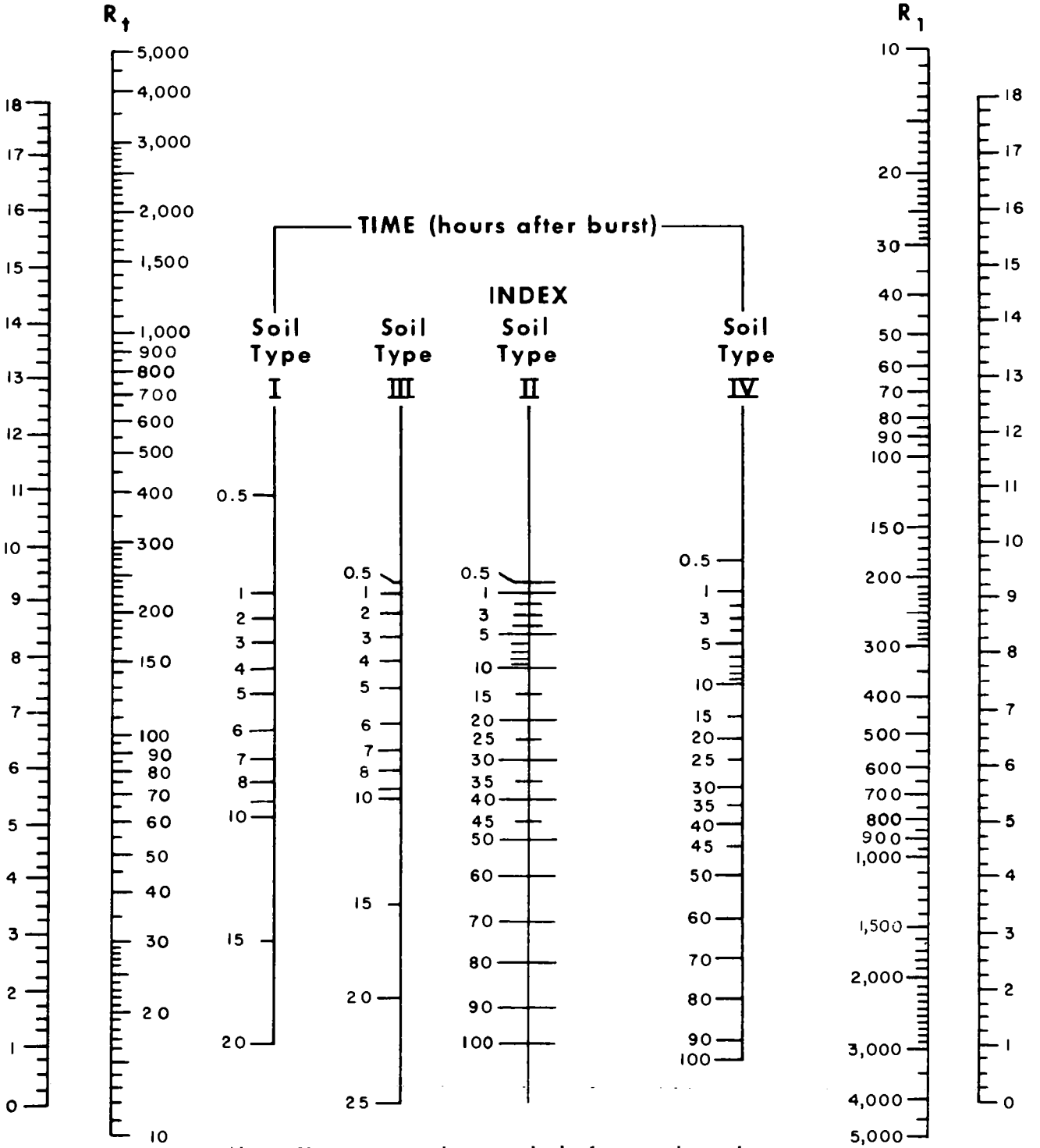
(*c*) On foot.

(3) *Maximum dose-rate point.* When crossing an area of induced radiation, the commander should note the point of maximum dose rate. At this point he is closest to ground zero, and, as a rough estimate, he can assume that his total traversal dose will equal two times the current dosimeter reading at the point of maximum dose rate; that is, assuming the dosimeter reading was zero before entering the area. Beyond this maximum dose-rate point, it will usually be just as safe to continue to advance or to move laterally away from ground zero rather than to withdraw. If the dose rate is becoming prohibitively high, causing the total dose to approach the operation exposure guide, prior to reaching this maximum dose-rate point, the commander may elect to change his route of advance or withdraw, depending upon the tactical situation.

d. Occupancy of an Area. Routine occupancy of an area of induced radiation is possible in from 2 to 5 days after burst. In the case of occupancy, low dose rates become of greater significance. This will be because of the accumulated dose acquired over the indefinite period of exposure. A commander should seek the least contaminated region available, consistent with his mission. During operations in a radiation field, the dosimeter should be checked frequently.

5–13. Decay Calculations

a. Variable Decay. The rate of decay of induced radiation is considerably different from that of fallout. The rate of decay of fallout is dependent upon the fission products produced in the burst itself and can be calculated by using the Kaufman equation (para 7–18*a*). On the other hand, soil composition is the most important factor in the decay of induced radiation. Since soil composition varies



Note. Use type II soil as standard, if type soil is unknown.

Figure 5–8. Residual radiation decay (induced).

widely, even in a very localized area, the actual chemical composition of the soil must be known to be able to determine the rate of decay of induced radiation. For this reason, four types of soil have been selected to show the wide variance in the predicted dose rates and decay rates. See DASA EM-1 for chemical composition of soils for the four soil types. Since the actual soil composition will not normally be known, soil type II has been chosen as standard for decay and total dose calculations. Soil type II will be used for all calculations until the unit is advised to use a different soil type.

★*b. Decay Nomograms.* The decrease in the radiation dose rate can be calculated by the use of a nomogram. The residual radiation decay (induced) nomogram, figure 5–8, allows the user to predict the dose rate at any time if a dose rate at any time after the burst is available. The nomogram contains four scales which denote time after burst (in hours) for four soil types (I, II, III, and IV), as indicated above each scale. The scale for soil type II is indicated as an index scale and will be used in calculations when the soil composition is not known (*a* above). The R_1 scale, at the right of the time scales, shows dose rates at H + 1; the R_t scale, at the left of the time scales, shows dose rates at times other than H + 1. The outside left and right lines are reference lines to be used in alining the hairline. Use of the decay nomogram is shown in the examples below.

c. Example Problems. In working with nomograms, care should be taken to be as consistent as possible when joining values with the hairline. Be sure the hairline intersects the vertical line and the interpolated value (tickmark) as closely as possible. The following problems are concerned with technique only and do not consider the impact that these high dose rates might have on operations in the contaminated area.

(1) *Example problem 1.*

GIVEN. $R_t = 150$ rad/hr at H + 3 hours.
FIND. R_1.
ANSWER. 190 rad/hr.
SOLUTION. Since the soil type (composition) is not known, calculations will be performed on the soil type II (index) scale. Aline the hairline with the 3-hour tickmark on the soil type II (index) scale and the 150 rad/hr point on the R_t scale. Read the dose rate as 190 rad/hr at the point of intersection with the R_1 scale.

(2) *Example problem 2.*

GIVEN. $R_1 = 300$ rad/hr.
FIND. R_t at H + 7 hours when the soil composition approximates soil type III.
ANSWER. 50 rad/hr.
SOLUTION. Aline the hairline with the 7-hour tickmark on the soil type III scale and equal values of the left and right reference lines. Pivot the hairline about its point of intersection with the index scale to the 300 rad/hr point on the R_1 scale. Read the dose rate as 50 rad/hr at the point of intersection with the R_t scale.

(3) *Example problem 3.*

GIVEN. $R_1 = 280$ rad/hr.
FIND. Time when $R_t = 90$ rad/hr.
ANSWER. H + 15 hours.
SOLUTION. Since the soil type is not indicated, soil type II must be used for this calculation. Connect 280 rad/hr on the R_1 scale and 90 rad/hr on the R_t scale. Read time as H + 15 hours on the soil type II (index) scale.

(4) *Example problem 4.*

GIVEN. $R_1 = 200$ rad/hr.
FIND. Time when $R_t = 70$ rad/hr in soil type IV.
ANSWER. H + 10 hours.
SOLUTION. Connect 200 rad/hr on the R_1 scale and 70 rad/hr on the R_t scale. Holding the hairline firmly at its point of intersection with the index scale, aline equal values on the left and right reference lines. Read time as H + 10 hours at the point of intersection with the soil type IV scale.

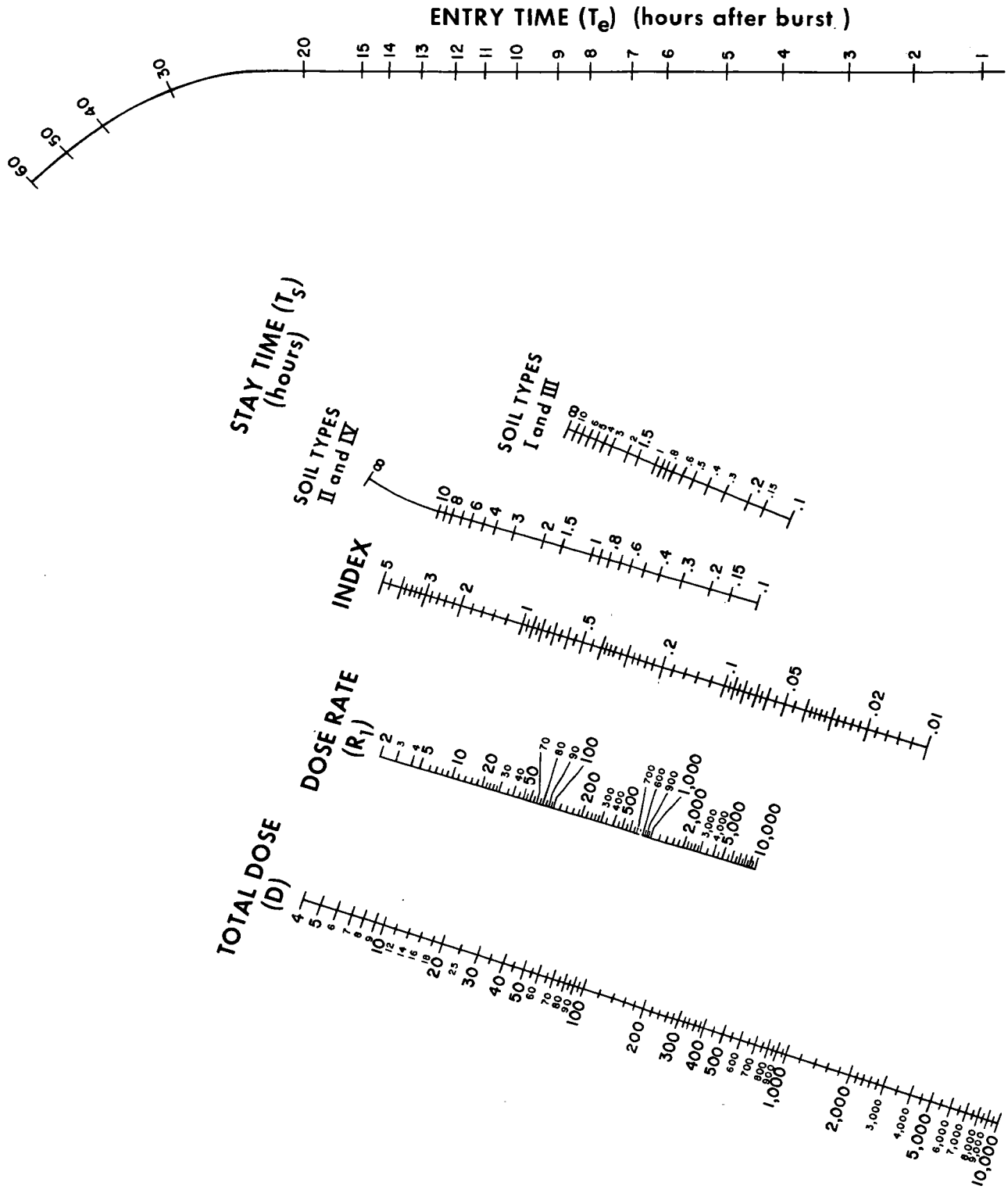


Figure 5-9. Total dose (induced radiation).

(5) *Example problem 5.*

GIVEN. Monitoring data from a unit occupying foxholes in an induced radiation area:

Time (hours after burst)	Ground Dose rate (rad/hr)
H + 1	40
H + 5	23
H + 6	17
H + 7	15

FIND. Soil type in which decay approximates the data above.

ANSWER. Soil type IV.

SOLUTION. Connect 40 rad/hr on the R_1 scale and 23 rad/hr on the R_t scale. Holding the hairline firmly at its point of intersection with the index scale, aline equal values on the left and right reference lines. Check the intersection of the hairline with each of the four soil types to determine which is closest to H + 5; repeat this procedure, using the dose rates at H + 6 and H + 7. A review of the results will indicate that the decay of contamination from soil type IV approximates the data given.

5–14. Total Dose Calculations

a. Total Dose Nomogram. The nomogram in figure 5–9 is used for predicting total dose to be received while in an induced radiation area. This nomogram relates total dose, dose rate 1 hour after the burst, stay time, and entry time. The two scales at the left show total dose and dose rate at H + 1, as indicated. Two time scales are positioned under stay time; the left scale is for soil types II and IV and the right scale is for soil types I and III. The index scale is a pivoting line which is used as an intermediate step between D and R_1 and T_s and T_e. These symbols represent the same terminology as used in paragraphs 5–1 through 5–7.

★*b. Essential Information.* If the available dose rate was taken at a time other than H + 1 hour, the R_1 value can be found by using the residual radiation decay (induced) nomogram (fig. 5–8) as described in paragraph 5–13*c*(1) for soil type II or when soil type is not known. For soil type I, III, or IV, paragraph 5–13*c*(1) should be modified as follows: Aline the hairline with the time after burst tickmark on the proper soil type scale and equal values of the left and right reference lines; pivot the hairline about the point of intersection with the index scale to the proper R_t, reading on the R_t scale; read the H + 1 dose rate at the point of intersection with the R_1 scale. On figure 5–9, the scale, soil types II and IV, under stay time will be used for total dose calculations if the soil type is not known. If the soil type is known, the appropriate scale under stay time will be used. It is possible to find any one value on the total dose nomogram if the other three are given, as illustrated in the examples below.

c. Example Problems. These problems are concerned with techniques only and do not consider the impact that the dose or dose rates might have on operations in a contaminated area.

(1) *Example problem 1.*

GIVEN. R_1 = 140 rad/hr.
T_s = H + 6 hours.
T_e = 1 hour.

FIND. D.

ANSWER. 72 rad.

SOLUTION. Since no soil type is indicated, use the scale for soil types II and IV under stay time. On figure 5–9, connect H + 6 hours on the T_e scale and 1 hour on the T_s scale (soil types II and IV) with the hairline. Pivot the hairline at its point of intersection with the index scale to 140 rad/hr on the R_1 scale. Read 72 rad on the D scale at the point of intersection with the hairline.

(2) *Example problem 2.*

GIVEN. R_1 = 300 rad/hr.
T_s = H + 6 hours.
T_e = 1 hour.
Soil type I.

FIND. D.

ANSWER. 70 rad.

SOLUTION. On figure 5–9, connect H + 6 hours on the T_e scale and 1

hour on the T_s scale (soil types I and III) with the hairline. Pivot the hairline at its point of intersection with the index scale to 300 rad/hr on the R_1 scale. Read 70 rad on the D scale at the point of intersection with the hairline.

(3) *Example problem 3.*

GIVEN. D = 25 rad.
R_1 = 100 rad/hr.
T_s = 0.4 hour.
Soil type III.

FIND. T_e.

ANSWER. H + 3 hours.

SOLUTION. On figure 5–9, connect 25 rad on the D scale and 100 rad/hr on the R_1 scale with the hairline. Pivot the hairline at its point of intersection with the index scale to 0.4 hour on the T_s scale (soil types I and III). Read H + 3 on the T_e scale at the point of intersection with the hairline.

5–15. Crossing an Induced Radiation Area

a. General. Induced radiation areas often may be avoided. However, the tactical situation may require that units cross an area in which there is induced radiation.

b. Average Dose Rate. In calculations of total dose, it is necessary to determine an average dose rate since the dose rates will increase as the center of the area is approached and then will decrease beyond the center of the area. The average dose rate represents a mean value to which the individual is exposed during the time of stay. A reasonable approximation of the average dose rate can be obtained by dividing by two the maximum dose rate predicted to be encountered. Symbolically, this is written as $R_{avg} = \frac{R_{max}}{2}$.

c. Time of Stay. Time of stay (stay time) must be calculated for crossing problems. Use the relationship of $T_s = \frac{\text{distance}}{\text{speed}}$.

d. Example Problem. An example problem is given below for calculation of dose when crossing an induced radiation area.

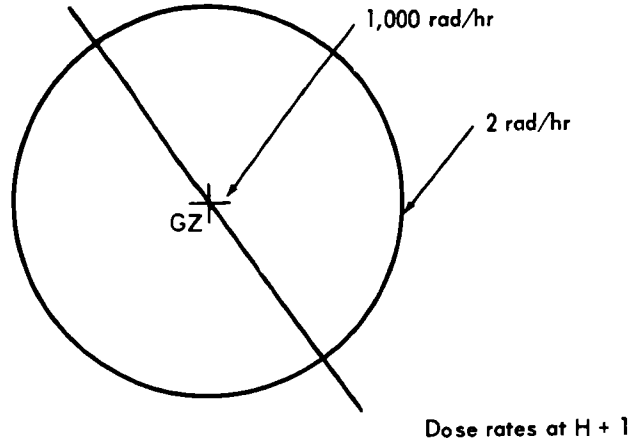


Figure 5–10. Example problem, crossing an induced radiation area.

GIVEN. A crossing will take place as shown in figure 5–10 at H + 20 hours. Distance of the route across the area is 1.0 kilometer; the rate of speed during the crossing, on foot, will be 5 kilometers per hour.

FIND. D.

ANSWER. 20 rad.

SOLUTION. $R_{1\ (avg)} = \frac{R_{max}}{2}$

$= \frac{1{,}000 \text{ rad/hr}}{2}$

$= 500$ rad/hr.

$T_s = \frac{\text{distance}}{\text{speed}}$

$= \frac{1.0 \text{ km}}{5 \text{ kmph}}$

$= 0.2$ hour.

T_e = H + 20 hours

On figure 5–9, connect 0.2 hour on the T_s scale (soil types II and IV) and 20 hours on the T_e scale with a hairline. Pivot through the point of intersection with the index scale to 500 rad/hr on the R_1 scale; read a total dose of 20 rad on the D scale at the point of intersection with the hairline.

5–16. Shielding of Neutron-Induced Radiation

The transmission factors for neutron-induced radiation can be approximated by the factors for fallout in figure 5–3, though they may be higher by as much as 70 percent.

Section IV. MARKING OF CONTAMINATED AREAS

5–17. General

★This section contains the procedures for the marking of radiologically contaminated areas. The information in this section is in agreement with STANAG 2002. These procedures are designed both for the protection of personnel of the units responsible for the areas concerned and for the prevention of casualties or unnecessary exposure of individuals of other commands resulting from unknowingly traversing contaminated areas. The marking of a contaminated area will merely indicate the presence of a hazard, the extent of which either has been or must be determined by monitoring or survey. TOC's at major headquarters will maintain current CBR situation maps that will portray the current contaminated areas, and this information will be disseminated in accordance with local SOP.

5–18. Marking Procedures

★Radiological contamination marking signs will be placed by monitors and/or survey parties on principal routes leading into contaminated areas at points where the dose rate reaches 1 rad/hr measured at 1 meter above the ground. The signs will be moved by monitors or survey parties each time they recheck the area to insure that the contamination markers are placed on the edge of the 1 rad/hr dose-rate contour. A daily recheck and movement of contamination markers should be sufficient for most situations. Traffic control personnel should normally be stationed near the radiation markers in order to verbally inform all personnel traversing the contaminated area of the extent of contamination. However, in the absence of traffic control personnel, sufficient information will be placed on the sign to adequately warn all individuals traversing the contaminated area. Control personnel should be located outside the exclusion area to minimize exposure to personnel. A direct reading dosimeter should be worn by control personnel.

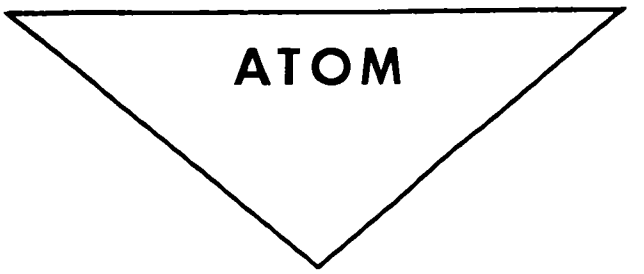
5–19. Signs

★The radiological contamination marking sign (fig. 5–11) will be in the shape of a right-angled isosceles triangle with a base of approximately 28 centimeters and sides of approximately 20 centimeters. The triangle is painted white on both sides. The word ATOM in black is placed on the side of the marker facing away from the contamination (front). In addition, the following details if known: dose rate, date and time of reading, and date and time of burst, are to be written on each sign, preferably on the front surface.

5–20. Guidance

a. The command responsible for an area plans and maintains the contamination marking signs. Commands leaving an area or otherwise giving up responsibility for an area will leave perimeter signs in place. The command taking over responsibility for the area will continue the daily movement of the signs or remove them when they are no longer necessary; that is, when the dose rate falls below 1 rad/hr.

b. At the discretion of the commander, a radiologically contaminated area need not be marked when a military advantage would be obtained by not doing so. In such cases, guards will be placed on the principal routes of entry to warn other friendly forces of the existence of the radiologically contaminated area.



DOSE RATE
DATE AND TIME OF READING
DATE AND TIME OF BURST

SURFACE OF MARKER FACING AWAY
FROM CONTAMINATION
(FRONT)

★*Figure 5–11. Radiological contamination marking sign.*

CHAPTER 6

RADIATION EXPOSURE GUIDANCE

(NATO STANAG 2083, SEATO SEASTAG 2083)

6-1. General

★Military operations in nuclear warfare will be complicated by the necessity to control the exposure of personnel to nuclear radiation. The primary reasons for this control are to maintain the combat effectiveness of personnel and insure effective combat operations. The commander cannot be bound by any hard-and-fast rules os radiation exposure control; therefore, any control that is established should be flexible. He should be provided sufficient guidance so that these controls will prevent the unwitting overexposure of personnel and will interfere as little as possible with mission accomplishment.

6-2. Purpose

★The procedures outlined below provide the commander guidance to aid in successful employment of his command on the nuclear battlefield with minimum exposure of personnel to nuclear radiation.

6-3. Effect of Control of Radiation Exposure on Operations

All nuclear radiation, even in small doses, has some harmful effect on the body and should be avoided whenever it is possible to do so without interfering with military operations (STANAG 2083).

a. Control of radiation exposure may affect operations by influencing the commander's decisions in the selection of a course of action and of the units to be employed in a given operation. Continuous evaluation of unit radiation exposure levels is necessary to assist in making these decisions.

★*b.* Radiation exposure should be controlled to the maximum extent possible consistent with the mission. On occasion, this may tend to restrict operations, but if exposure control is ignored, the results could be disastrous. The establishment and use of operation exposure guides will aid the commander in keeping radiation exposures at a minimum and thus assist in accomplishment of the assigned mission.

★*c.* An operation exposure guide could be used to select units with low radiation doses to perform missions requiring exposure to radiation. Without due consideration, it might be said that "the selection of an operation exposure guide of 20 rad, 30 rad, or 50 rad for one operation will not cause casualties." This may be true for a unit that previously has absorbed no radiation. However, if a unit already has a dose of 140 rad, an additional 50 rad probably would make the unit ineffective. On the other hand, if a unit already has a dose of only 20 rad, the additional 50 rad would not make it ineffective. This points up the fact that operational records should continuously reflect the radiation status of units. Reclassification of units from a serious radiation status category to a less serious one may be made by the commander upon advice of the surgeon after ample observation of the actual state of health of the exposed personnel.

★*d.* It would be meaningless to establish ONE numerical value or acceptable degree of risk as an operation exposure guide to be valid

for all subordinate units throughout a campaign. The establishment of an operation exposure guide for a particular unit depends on that unit's previous exposure history. An operation exposure guide must be established for each operation and must be based upon the radiation exposure status of the unit at that time and upon the combat situation.

e. Some simple formulas for determining the turn-back dose or turn-back dose rate in radiological survey operations, after the commander has established an operation exposure guide, are given in paragraph 4–4.

6–4. Operation Exposure Guidance

★*a. Categories of Exposure.* Effective use of radiation exposure records permits rapid determination of a unit's potential to operate in a radiologically contaminated area. Dose criteria have been established in four categories: Radiation Status—0 (RS–0), Radiation Status—1 (RS–1), Radiation Status—2 (RS–2), and Radiation Status—3 (RS–3). Dose criteria, which are based on *the best available estimates* on predicting the effects of radiation exposure, are given in tables 6–1 and 6–2 for each category. The four radiation status categories are defined below.

(1) *Radiation status—0 (RS–0).* RS–0 applies to a unit that has never been exposed to nuclear radiation—a unit which has received no dose.

(2) *Radiation status—1 (RS–1).* RS–1 applies to a unit that has been exposed to nuclear radiation—a unit which has received a dose greater thas 0 but less than, or equal to, 70 rad.

(3) *Radiation status—2 (RS–2).* RS–2 applies to a unit that has received a significant but not dangerous dose of radiation—a unit which has received a dose greater than 70 rad but less than, or equal to, 150 rad. If the situation permits, units in this category should be exposed less frequently and to smaller doses than the units in RS–1 or RS–0 categories.

(4) *Radiation status—3 (RS–3).* RS–3 applies to a unit that has already received a dose of radiation greater than 150 rad, which makes further exposure dangerous. In other words, this unit should be exposed only if unavoidable, because additional exposure in the immediate future would result in sickness and probably some deaths.

★*b. Degrees of Risk.* The degree-of-risk concept furnishes guidance to assist the commander in establishing an operation exposure guide for a single operation and in minimizing the number of casualties from nuclear radiation. By using the radiation status categories of subordinate units (table 6–1) and the degree of risk he will accept, the commander can establish an operation exposure guide based on the degree-of-risk criteria in table 6–2. There are three degrees of risk: negligible, moderate, and emergency. Each of these can be applied to radiation hazards resulting from enemy or friendly weapons, or both, and from initial nuclear radiation resulting from planned friendly supporting fires. Degrees of risk are defined in terms of percent incidences of either casualties or performance degradation. From a radiation standpoint, the effect considered to cause performance degradation (but not casualties) is vomiting, which is commonly termed a "nuisance" effect. The radiation aspects of degrees of risk are discussed below. (See FM 101–31–1 for a complete discussion of degrees of risk, to include the blast and thermal effects.)

(1) *Negligible risk.* Troops receiving a negligible risk dose will not experience more than a 2.5-percent incidence of vomiting. This dose will cause no casualties. The negligible risk dose is 50 rad for units with no previous dose (RS–0 units), and appropriately less for previously exposed units. A negligible risk is acceptable in any case in which the use of nu-

★*Table 6–1. Dose Criteria for Placing Units in Radiation Status Categories*

Radiation status category	Numerical criteria Total cumulative dose (rad)
RS–0	0 (no exposure)
RS–1	Greater than 0 but less than, or equal to, 70
RS–2	Greater than 70 but less than, or equal to, 150
RS–3	Greater than 150

clear weapons is desirable. Negligible risk should not be exceeded unless significant advantage will be gained.

(2) *Moderate risk.* Troops receiving a moderate risk dose will not experience more than a 5-percent incidence of vomiting. This dose will cause no casualties. A moderate-risk dose is 70 rad for units with no previous dose, and appropriately less for previously exposed units. A moderate risk is considered acceptable in close support operations; for example, to create a gap in enemy forward positions or to halt an enemy attack. Moderate risk should not be exceeded if troops are expected to operate at full efficiency after a friendly burst.

(3) *Emergency risk.* Troops receiving an emergency risk dose will not experience more than a 5-percent incidence of casualties, but the incidence of vomiting may be higher. An emergency risk dose is 150 rad for units with no previous dose, and appropriately less for previously exposed units. An emergency risk should be accepted only when it is absolutely necessary, and should be exceeded only in extremely rare situations that might be loosely called "disaster" situations. No attempt is made to define disaster situations. The commander must determine these extremely rare situations for himself and decide which criteria are appropriate to use in attempting to salvage them.

★*c. Use of the Degree-of-Risk Concept.* The possible exposure criteria for a single operation that will not exceed the dose criteria for a stated degree of risk are given in table 6–2. The risk criteria for the RS–1 and RS–2 categories are based on assumed average exposures for units in RS–1 and RS–2 (40 rad for RS–1 and 110 rad for RS–2). These criteria should be used only when the numerical value of the total past cumulative dose of a unit is unknown. When the total past cumulative dose of a unit within a category is known, a criterion for the desired degree of risk can be obtained by subtracting the known dose from the RS–0 criterion for the degree of risk of concern. For example, if a unit in RS–1 is known to have received 30 rad, it may receive an additional dose of 20, 40, or 120 rad, respectively, before exceeding the

★*Table 6–2. Nuclear Radiation Degree of Risk Exposure*

Radiation atatus category [1, 2]	Total past cumulative dose [3] (rad)	Possible exposure criteria for a single operation which will not result in exceeding the dose criteria for the atated degree of risk [4, 5] (rad)
RS–0 units	No exposure	Negligible Risk: ≦ 50 Moderate Risk: ≦ 70 Emergency Risk: ≦ 150
RS–1 units	Greater than 0, but less than or equal to 70	Negligible Risk: ≦ 10 Moderate Risk: ≦ 30 Emergency Risk: ≦ 110
RS–2 units	Greater than 70, but less than or equal to 150	Any further exposure is considered to exceed a negligible or moderate risk. Emergency Risk: ≦ 40
RS–3 units	Greater than 150	All further exposure will exceed the emergency risk.

[1] Radiation status categories are based on previoua exposure to radiation.

[2] Reclassification of units from one radiation status category to a less serious one is made by the commander upon advice of the surgeon after ample observation of actual state of health of the exposed personnel.

[3] All exposures to radiation are considered total body and simply additive. No allowance is made for body recovery from radiation injury.

[4] Risk levels are graduated within each status category to provide more stringent criteria aa the total radiation dose accumulated becomes more serious. The exposure criteria given for RS–1 and RS–2 units should be used only when the numerical value of a unit's total past cumulative dose is unknown. Otherwise, thc criterion for the desired degree of risk should be obtained by subtracting the numerical value of ths unit's dose from the RS–0 criterion for the desired degree of risk.

[5] Each of the degrees of risk can be applied to radiation hazards resulting from enemy or friendly weapons, or both, and from initial nuclear radiation resulting from planned friendly supporting fires.

negligible, moderate, or emergency dose criterion.

★*d. Expression of Operation Exposure Guide.* The operation exposure guide will be established for all levels of command, from the division down to and including the company. The expression of the operation exposure guide will vary with the level of command. Normally, the division and brigade will express the operation exposure guide as the acceptable degree of risk for the particular operation. On the other hand, the battalion normally will express the operation exposure guide as a numerical exposure for each of its units according to its past exposure history, current operation plans or orders, and the situation. Under extreme conditions, the division and/or brigade may establish a numerical operation exposure guide.

6–5. Radiation Exposure Records

The operation exposure guide concept requires that radiation exposure records be maintained on all units. The most realistic unit exposure data are based on readings obtained at the platoon level because companies are often so deployed that the platoons may not be located in areas of equal radiation dose rates or remain in these areas for like periods of time.

a. Reporting Procedures. Unit radiation exposure records are normally maintained at battalion and higher level. Since this concept calls for platoon radiation exposure information and the company does not have the capability to properly evaluate these records, battalion will maintain radiation exposure records down to and including the organic and attached platoon. Reports on the radiation exposure status of small units are not normally forwarded higher than battalion. Battalion will forward to brigade and division its own radiation status, based on the radiation status of organic and attached companies. Table 6–4 will serve as a guide for the determination of the battalion radiation status. This information will assist both the division commander and the brigade commander in establishing operation exposure guides, degrees of risk, and composition of task forces for missions requiring further radiation exposure.

★*b. Radiation Dose Status Chart.* Since the operation exposure guide concept calls for maintenance of platoon radiation exposure records, the exposures must be collated and translated into usable data. To provide a rapid means of evaluating the exposures, the radiation dose status chart (table 6–3) is used. All organic and attached platoons in the battalion are listed in the platoon column. The dose received, in units of 10 rad, is posted daily or after each exposure and is indicated by an upright tally mark: || for 20 rad, |||| for 40 rad, 𝍸|| for 60 rad, and so on, in the appropriate date column. By using the criteria from table 6–1, RS–0, RS–1, RS–2, or RS–3 is determined for each platoon and entered in the radiation status column. For example, on 7 June the chart may look like table 6–3. The 2d platoon of Company A received 20 rad on 1 June, 20 rad on 2 June, and 40 rad on 7 June, giving a cumulative total dose of 80 rad. Note that even though the platoon was RS–0 at the beginning of the period, on 1 June it became RS–1 and on 7 June it became RS–2, based on criteria of table 6–1. The radiation status of the company (para 6–7*b*) is determined from table 6–4 and is posted below the individual platoon status. Since the radiation status may change daily, charts covered with acetate will assist in reducing the number of charts necessary for maintenance of current radiation records.

★*a. Flow of Dosimetry Information.* Typical flow of dosimetry information in the infantry division is illustrated in figure 6–1.

★*b. Data Handling Procedures.* The step-by-step procedures for handling dosimetry information from the tactical dosimeters of an infantry platoon are described below; the procedures are also applicable to other similar organizations.

(1) The tactical dosimeters will be read daily or more often if the situation dictates.

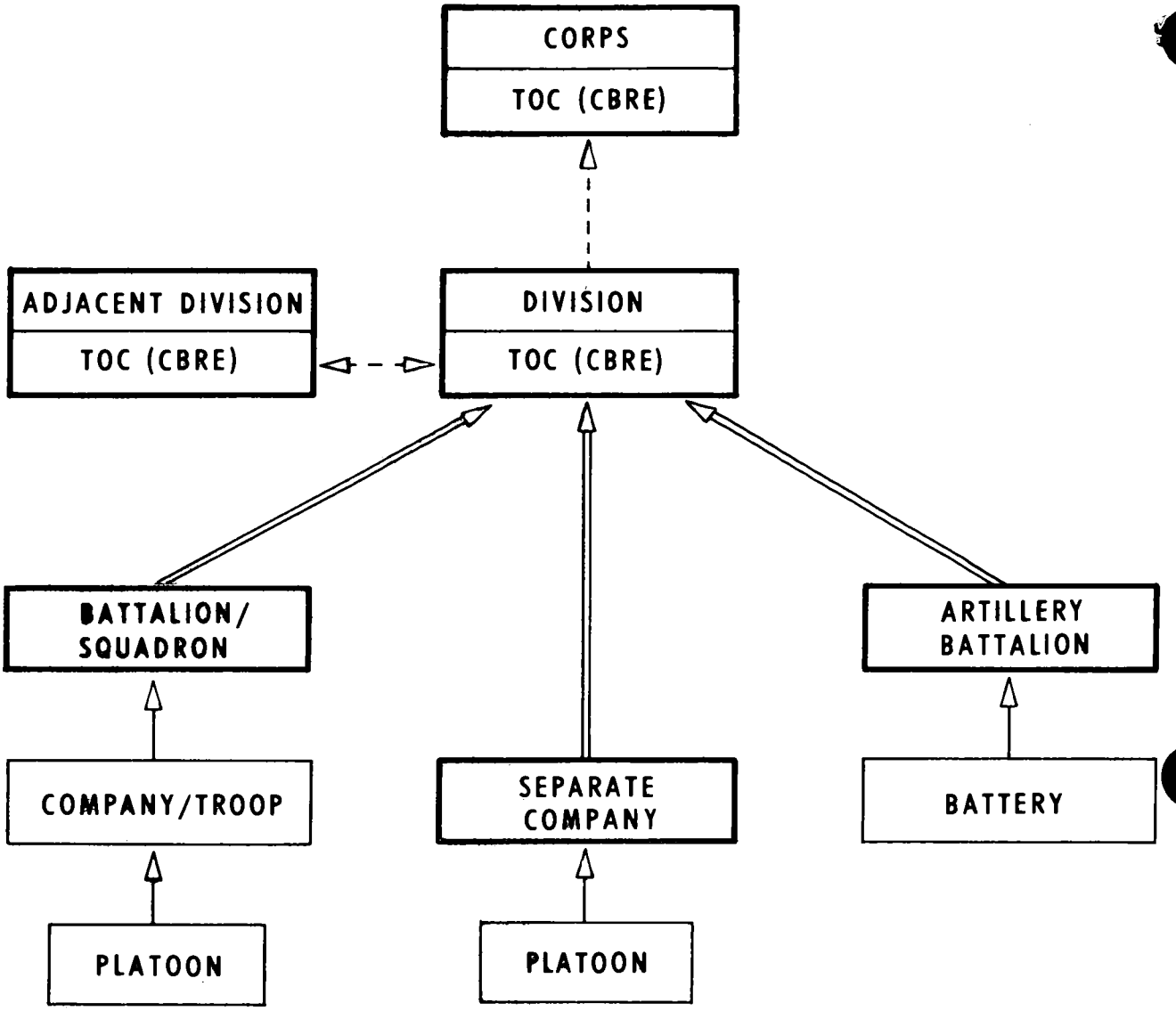
★(2) The net readings of the two platoon dosimeters will be averaged, rounded off to the nearest 10 rad, and reported to company. If there is reason to believe that the reading from one dosimeter is not representative of the platoon (for example, the person carrying the dosimeter was shielded or operating away from the platoon), then only the reading from the one representative dosimeter should be reported. An alternate unit dosimeter wearer is assigned for each dosimeter so that the unit dosimeter may remain with the platoon when the primary wearer leaves the platoon area. The platoon reports to company only the "net" reading, that is, the amount accumulated since the last reading. In other words, the person reading the instrument makes a note of the reading each time the dosimeter is read; the next time the dosimeter is read, only the difference between the two readings is reported. The readings can be jotted down in a pocket notebook, and kept until the next reading; no permanent record need be kept. Dosimeters are read and the readings reported before recharging the dosimeter. In this case the next reported reading (after the recharging) is the total reading. If the individual with the dosimeter is evacuated or transferred to another unit, the dosimeter stays with the platoon.

(3) The platoon readings are reported by radio or telephone daily (or when the situation permits) by company to the S3 at battalion or similar-size unit as part of an established operational type report required by unit SOP, except when units are exposed to relatively high doses (that is, established operation exposure guide has been exceeded). In the latter case, reports should be processed without delay. The unit SOP will specify the time and method of routinely reading and transmitting this information to the next higher headquarters.

(4) At battalion (or similar echelon), a chart (table 6–3) is kept depicting the radiation status of each platoon and company organic or attached to the battalion. [The chart should be constructed of waterproof and lightweight (for example, transparent plastic) material and be small in size.] The radiation status category for each platoon is determined by using criteria from table 6–1 and is then entered on the chart. The RS numbers for all organic and attached platoons in any one company are then summed. Based on this sum and on the total number of platoons in that company, the company radiation status category (para 6–7*b*) is determined from table 6–4.

★(5) The battalion (and separate units attached to the brigade) forwards radiation status information daily (or after each operation) over command channels through brigade to division, as part of the periodic operations report. Battalion will forward its own radiation status, based on the radiation status of organic and attached companies. Table 6–4 will serve as a guide for this determination. The information is sent to the division TOC and is usually retained in the CBR element. Normally, only the battalion status information is of interest to the brigade or division commander. If these commanders desire more specific information, it is obtained from battalion at the commander's request. These commanders establish SOP's outlining the radiation exposure information that they desire from battalion.

(6) In some cases elements of one unit are attached to another unit. For example, elements of a tank battalion are attached to another battalion or to another brigade. The radiation status of these units is kept by the unit to which they are attached. When units return to their parent unit, the parent unit is informed of their unit radiation exposure history and current status. If the parent organization desires to know the radiation status of its detached units, it contacts the headquarters of the unit to which they are attached.



– – – – – Processed data on request only

═══ Processed data through intervening headquarters (for example, brigade)

——— Basic unit data

Bold blocks indicate units that keep radiation dose status charts.

★*Figure 6–1. Typical flow of unit dosimetry information at division.*

(7) The dosimetry information concerning divisional units is not forwarded higher than the division headquarters unless specifically requested. Instead, the general radiation status is made a part of overall reports of the division's combat effectiveness.

★6-6.1. Processing Data From Tactical Dosimeters in the Corps

Figure 6-2 illustrates the typical flow of unit dosimetry information in the corps.

a. Data Handling Procedures. Data handling procedures for corps units are similar to those for division units (para 6-6*b*).

b. Processing Data. Dosimetry information for corps units is processed as follows:

(1) Headquarters and headquarters company, corps, maintains the radiation dose status charts of its platoons and other small units of interest (sections, separate teams, and other units that operate separately) in the company. The company forwards its radiation status to the corps TOC (CTOC) where it is usually retained in the CBRE.

(2) Corps artillery battalions maintain unit radiation dose status charts, including each battery only (not platoons as is the case for most other battalions—for example, infantry, armor) in their battalion. The battalion status is forwarded through corps artillery headquarters (and field artillery groups, if appropriate) to the CTOC. Separate corps artillery batteries (such as the searchlight battery) maintain their radiation dose status charts, and their radition status information is forwarded through corps artillery headquarters to the CTOC.

(3) Other corps battalions (such as aviation, chemical, signal, and information and surveillance) and squadrons maintain the unit radiation dose status charts of their respective platoons and companies/troops. The evaluated battalion status information is forwarded to the CTOC (through group and/or brigade, as appropriate).

(4) Separate companies, such as the topographic and mobile assault bridge companies, keep their own unit radiation dose status charts, and the radiation status information is sent to the CTOC (through intermediate headquarters, as appropriate).

(5) Radiation status information may be exchanged between the CTOC, adjacent CTOC's, and division TOC's (DTOC), as required. Also information may be exchanged between the corps support brigade area damage control center (ADCOC) and CTOC, as necessary. Normally, radiation status information will not be forwarded routinely to the field army TOC (FATOC). However, this information may be exchanged between corps and army, as required.

(6) Communication procedures for dosimetry information for corps units do not require special emphasis. Companies/batteries/troops report dosimetry information to battalion (or similar echelon) by radio or telephone daily (or when the situation permits). The reports are submitted as part of the operational report required by SOP, except when units are exposed to relatively high doses (that is, the established operation exposure guide has been exceeded). In the latter case, reports are processed without delay. Battalions (or similar-size units) report their radiation status to the CTOC through command channels.

★6-6.2. Processing Data From Tactical Dosimeters in the Field Army (Less Fascom)

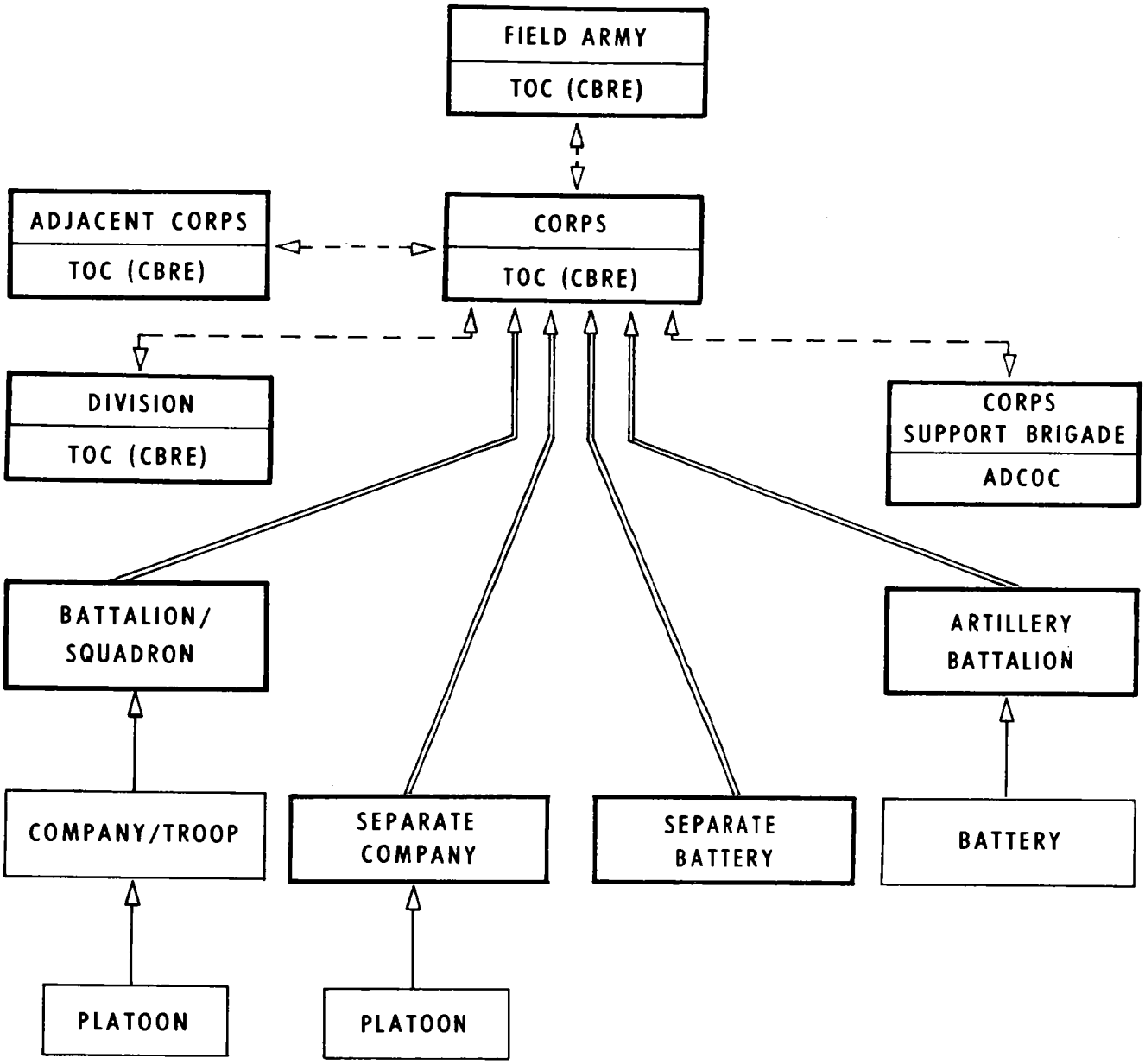
Figure 6-3 illustrates the typical flow of unit dosimetry information for the field army, less field army support command (FASCOM).

a. Data Handling Procedures. Data handling procedures for army units are similar to those for division units (para 6-6*b*).

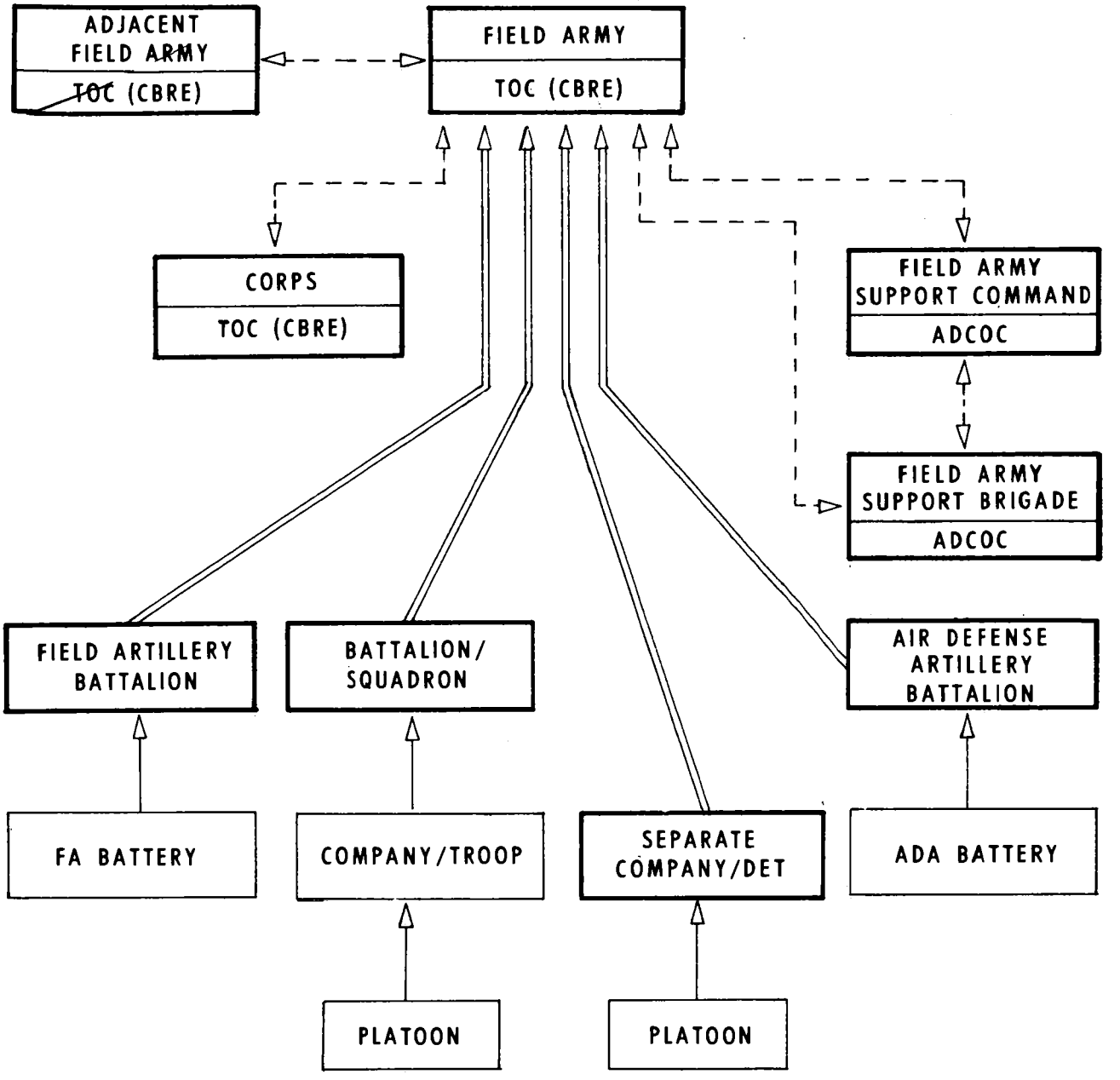
b. Processing Data. Dosimetry information for field army units is processed as follows:

(1) Separate companies (such as headquarters and headquarters company, army; army aviation company; air traffic regulating company) keep in the company headquarters the unit radiation dose status charts of their platoons. Each company forwards its calculated radiation status to the FATOC.

(2) In the air defense artillery brigade, the unit radiation dose status charts of batter-



★*Figure 6-2. Typical flow of unit dosimetry information at corps.*



---- Processed data on request only
═══ Processed data through intervening headquarters (for example, brigade)
——— Basic unit data
Bold blocks indicate units that keep radiation dose status charts.

★*Figure 6–3. Typical flow of unit dosimetry information at field army (less FASCOM).*

ies are kept at the appropriate battalion headquarters. The battalion radiation status information is forwarded (through air defense artillery group and brigade headquarters, if appropriate) to the FATOC. A similar procedure is followed for the field artillery battalion, PERSHING, except that in this case the battalion status will normally be sent directly to the FATOC.

(3) Other army units follow normal procedures. The battalion/squadron keeps the unit radiation dose status charts of its companies/troops (by platoon), and the battalion status is forwarded to the FATOC (through group and brigade, if required).

(4) Communication procedures from small units (platoon and/or company) to the battalion are generally similar to those for the division and corps. Units (battalion or separate company) reporting to the FATOC do so over the army area communications system.

(5) The FATOC may exchange dosimetry information, as required, with the army support brigade ADCOC, FASCOM ADCOC, CTOC, or adjacent FATOC. The communications used for the exchange of this information will usually be the command-oriented subsystem.

★6–6.3. Processing Data From Tactical Dosimeters in FASCOM

Figure 6–4 illustrates the typical flow of unit dosimetry information for FASCOM units.

a. Data Handling Procedures. Data handling procedures for FASCOM units are similar to those for division units (para 6–6*b*).

b. Processing Data. Dosimetry information for FASCOM units is processed as follows:

(1) The battalions under each support group maintain the unit radiation dose status charts of the companies (determined by platoons in the company) in the battalion. The radiation status information of the battalion is forwarded to the rear area operations center (RAOC) at group headquarters. Only on request should the RAOC at group headquarters forward the information on to the ADCOC at support brigade headquarters.

(2) The other battalions, separate companies, or detachments in the corps and army support brigades maintain the unit radiation dose status charts of their respective units and forward the radiation status information to the appropriate support brigade ADCOC (through intermediate headquarters, if required).

(3) The ADCOC in FASCOM headquarters maintains radiation status information of its headquarters and the attached functional units. Also, the radiation status of units in the brigades (medical, civil affairs, military police, and transportation) are kept in FASCOM ADCOC. Battalions and other units (such as hospitals, separate companies, and detachments) under the various brigades mentioned above maintain the radiation status of their units. The radiation status information of the battalions (and other similar units) is forwarded through the appropriate brigade to the ADCOC in FASCOM. For control purposes, the brigade headquarters may also wish to keep unit radiation dose status charts of the major units under the brigade.

(4) The unit radiation dose status charts of units under the support brigade are kept by the ADCOC of the support brigade. This information is not routinely furnished the FASCOM ADCOC, but information may be furnished upon request.

(5) Radiation status reports should normally be made over the army area communications system. Exchange of information among major headquarters echelons should normally be made over the command-oriented communications subsystem.

★6–6.4. Processing Data From Tactical Dosimeters in the Communications Zone

Figure 6–5 illustrates the typical flow of unit dosimetry information for the communications zone. The centers that are most suitable for handling tactical dosimetry information in the communications zone are the ADCOC at area support command (ASCOM) and the RAOC's at each area support group.

a. Data Handling Procedures. Data handling procedures for COMMZ units are similar to for division units (para 6–6*b*).

★*Table 6–3. Radiation Dose Status Chart, Month 6*

Platoon	Company	Date [1]								Present radiation status	Remarks
		1	2	3	4	5	6	7	30		
A1		||	||				|	|||		RS–2	RS–0 on 31 May RS–1 on 1 Jun RS–2 on 7 Jun
A2		||	||					||||		RS–2	RS–0 on 31 May RS–1 on 1 Jun RS–2 on 7 Jun
A3		|||	|	||	|||			||		RS–2	RS–0 on 31 May RS–1 on 1 Jun RS–2 on 4 Jun RS–2 on 7 Jun
A4		|	|		|			|		RS–1	RS–0 on 31 May RS–1 on 1 Jun RS–1 on 7 Jun
Engr platoon					|	|	||			RS–1	RS–0 when attached on 2 Jun RS–1 on 4 Jun RS–1 on 7 Jun
	A										RS–2	RS–0 on 31 May RS–1 on 1 Jun RS–2 on 7 Jun

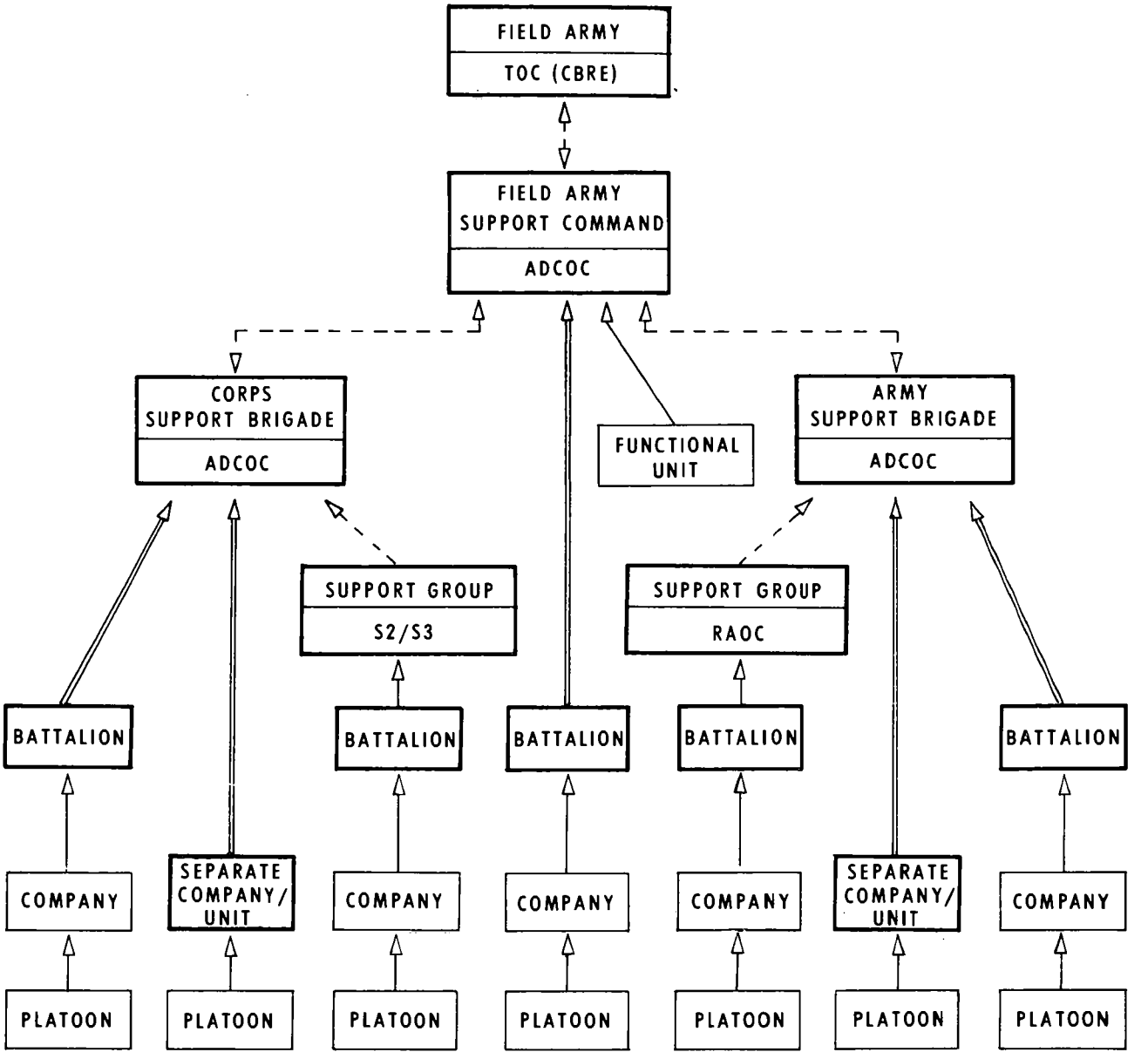
[1] The marks in the date columns are upright tally marks, each representing 10 rad.

★*Table 6–4. Company or Battalion Radiation Status Category*

Radiation status category of company or battalion	Number of platoons in company or number of companies in battalion					
	2	3	4	5	6	7
	Sum of RS numbers of all platoons or companies					
RS–0	0	0–1	0–1	0–2	0–2	0–3
RS–1	1–2	2–4	2–5	3–7	3–8	4–10
RS–2	3–4	5–7	6–9	8–12	9–14	11–17
RS–3	5–6	8–9	10–12	13–15	15–18	18–21

6–6. Processing Data From Tactical Dosimeters in the Division

The IM–93( )/UD tactical dosimeter is issued on the general basis of two per platoon or the smallest operational unit of interest. The platoon-size unit is the optimum size on which to maintain the radiation status. Processing of dosimetry information at the various echelons of division is described below.



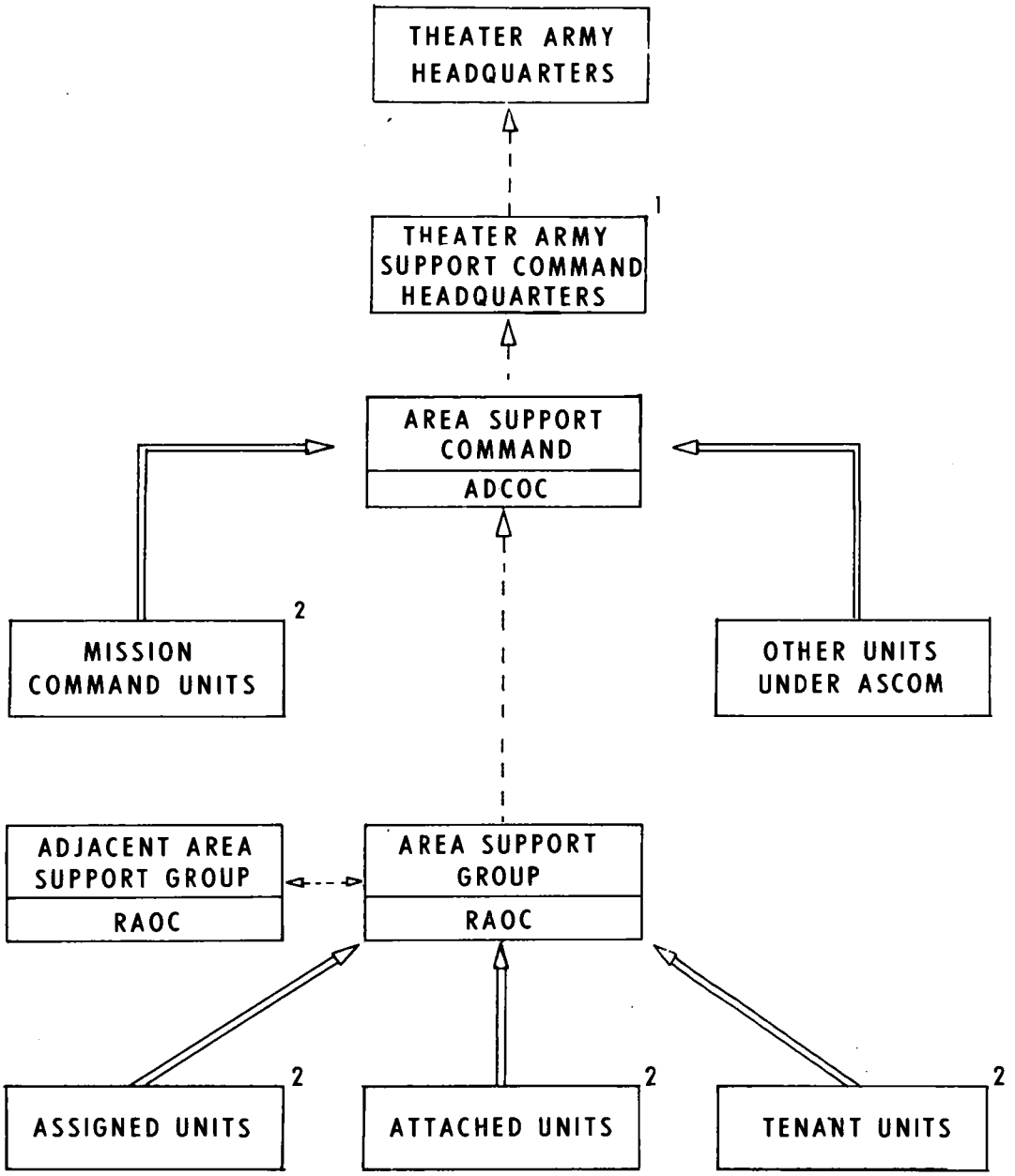
- - - - - Processed data on request only

═══ Processed data through intervening headquarters (for example, brigade)

——— Basic unit data

Bold blocks indicate units that keep radiation dose status charts.

★*Figure 6-4. Typical flow of unit dosimetry information at FASCOM.*



----- Processed data an request anly

═══ Processed data thraugh intervening headquarters

1 TASCOM HQ may nat be required.

2 Usually battalians ar separate companies ar detachments

★*Figure 6-5. Typical flow of unit dosimetry information in the communications zone.*

b. Processing Data. Dosimetry information for communications zone units is processed as follows:

(1) Units (battalions, separate companies, teams, detachments, hospitals, and similar units) under the 5-mission commands (engineer, transportation, personnel, medical, and supply and maintenance) under theater army support command (TASCOM) or theater army (TA), as appropriate, determine their unit radiation dose status charts. This information is forwarded to the ADCOC at ASCOM headquarters through appropriate command channels.

(2) Other units directly under the ASCOM, excluding the area support groups, maintain their radiation status information as described in paragraph 6–6 and forward the information through appropriate channels to the ADCOC at ASCOM headquarters.

(3) Each major unit (battalion, separate company, separate detachment or team) organic to each area support group maintains its radiation dose status chart. Also, other units in the area serviced by the area support group, such as attached units and area tenant units, maintain the radiation dose status charts of their respective units. The organic units and others forward their radiation status information to the RAOC at the appropriate area support group headquarters. The radiation status on units maintained at the RAOC of the various area support groups is not automatically forwarded to the ADCOC at ASCOM headquarters. This information is available to the ASCOM commander on a "request" basis. By request, the TASCOM or TA commander can, of course, obtain the radiation status of any units in the COMMZ from the ASCOM.

(4) The theater army area communications system of the theater army communications system (TACS) is normally used by units in the COMMZ to report radiation status information from units (battalion or company) to the appropriate ADCOC or RAOC.

6–7. Category Determination

★*a. Platoon Status.* Consider the status of the 2d platoon of Company A as depicted in table 6–3. At the start of the period, the platoon was RS–0, having received no radiation dose. The platoon received 20 rad on 1 June and thus became RS–1 on that date according to the criteria in table 6–1. The platoon received an additional 20 rad on 2 June. Again, using the criteria in table 6–1, at the end of the day on 2 June the unit was still classified RS–1, having received less than 70 rad. On 7 June the unit received 40 rad, making a total dose of 80 rad. Therefore, after the platoon received 40 rad on 7 June, it was classified RS–2.

★*b. Company Status.* Next, consider the status of Company A as depicted in table 6–3. At the start of the period, the company was classified RS–0. However, at the end of 1 June, each of the company's four platoons had been reclassified RS–1. The sum of the RS numbers of all the platoons in the company was 4. Enter table 6–4 under the sum of RS numbers column for four platoons, and find the block containing an RS number sum of 4 ("2–5"). Read the corresponding company radiation status category in the first column as RS–1. An engineer platoon classified RS–0 was attached to Company A on the night of 2 June. The sum of the RS numbers of all the platoons was still 4. Enter table 6–4 under the column for five platoons, and find the block containing an RS number sum of 4 ("3–7"). Read the corresponding company radiation status category, which indicates that it was still classified RS–1 on 2 June after attachment of the engineer platoon. On 4 June the 3d platoon became RS–2 and the engineer platoon became RS–1, increasing the sum of the RS numbers of all the platoons in the company to 6. According to table 6–4, however, the company was still classified RS–1. On 7 June Company A consisted of three RS–2 platoons and two RS–1 platoons, with an RS number sum of 8: 3(RS–2) + 2(RS–1) = 8. Table 6–4 indicates that the company was then classified RS–2.

★*c. Battalion Status.* If Company A's parent battalion consists of three other companies, each classified as RS–1, the battalion status would be reported to brigade on 7 June as RS–1 according to table 6–4, since the sum of the RS numbers is 5. If brigade and division

headquarters desire the radiation status of each company, these headquarters may request this information from battalion. However, if the status of reporting subordinate units differs markedly from battalion radiation status and could affect battalion operational capability, the battalion radiation status report should include a note reflecting this circumstance. For example, a battalion composed of three companies may be assigned an RS–1 category. Two of the companies may be RS–0 and one RS–3, which establishes the battalion RS–1 category (table 6–4. An indication of this circumstance would assist the brigade commander in the selection of units in the lower categories for a particular operation that necessitates exposure to radiation.

6–8. Dosimeter Recharging

★The IM–93( )/UD dosimeters are recharged when it is convenient to do so or when the total dose reads more than 500 rad. In order to prevent excessive leakage of charge with the resultant introduction of a false reading of dose received, the dosimeters are charged after not more than 2 or 3 days (preferably each day) if possible. A minimum of two chargers will be kept at company.

6–9. Chemical, Biological, and Radiological Element Responsibilities

Included among other functions, the CBRE of the TOC at division maintains on a daily basis the radiation exposure status of each battalion within the division. The exposure status of each battalion will be obtained from the periodic operations report. This information will enable the CBRE to provide the commander with estimates of situations that could produce radiological hazards to the battalions of the division. A similar procedure is appropriate for other operations and control centers performing CBRE-type functions (see figures 6–2, 6–3, 6–4, and 6–5).

6–10. Surgeon

a. In planning a particular operation, the staff surgeon usually is consulted early. His understanding of the effects of radiation on personnel, as well as other pertinent health factors, enables him to assist the commander and his coordinating staff in evaluating possible courses of action. On receiving the commander's tentative plan, the surgeon reviews the current health and radiation exposure status of the units involved (see table 6–2) and the exposure predicted in the plan. He then provides the commander with general estimates of—

(1) Anticipated reduction in effectiveness of personnel due to exposure to radiation.

(2) The number and time-phasing of casualties that may occur.

(3) The resulting medical workload and the requirements for medical units to perform it.

★*b.* Reclassification of units (table 6–2) from one radiation status category to a less serious one is made by the commander upon advice of the surgeon after ample observation of the actual state of health of exposed personnel has been made. To facilitate future evaluations and calculations, the surgeon should assign a specific numerical effective dose for personnel in the reassigned category.

6–11. Employment of an Operation Exposure Guide—Example

★It is 6 October. The battalion commander plans to commit Company B on 7 October in a radiologically contaminated area. He will accept a moderate risk. The radiation dose status chart (table 6–5) is checked, and the radiation status of Company B is determined to be RS–1. The commander notes from table 6–2 that an RS–1 unit may receive a dose less than or equal to 30 rad and not exceed a moderate risk. Therefore, he establishes an operation exposure guide of no more than 30 rad for Company B in this operation. He then examines the estimate of hazard shown on the contamination chart provided by the division CBRE. If it does not exceed the operation exposure guide, he consults with the S3 and the surgeon concerning the potential of B Company's personnel for

★*Table 6-5. Radiation Dose Status Chart, Month 10*

Platoon	Company	Date[1]							Present radiation status	Remarks
		1	2	3	4	5	6	31		
B1			||	||					RS-1	
B2			||	||					RS-1	
B3										★RS-0	
B4			||							RS-1	
	B									RS-1	

[1] The marks in the date columns are upright tally marks, each representing 10 rad.

successful accomplishment of the mission under the conditions contemplated. The steps discussed above usually precede finalization of an operations plan and are accomplished routinely through normal staff action.

6-12. Individual Dosimetry

★The preceding dosimetry information concerns unit dosimetry. As an interim measure until the US Army issues individual dosimeters to each soldier, the radiation dose status of the individual will be assumed to be the same as the status of the platoon or similar size unit to which he is assigned. When the individual is reassigned or evacuated through medical or other channels, his radiation status will be assumed to be the same as the status of the platoon or similar size unit to which he was last assigned. A notation of this status (RS-0, RS-1, RS-2, RS-3) may be made on the official records (morning report, medical records, or other appropriate records) when pertinent information concerning an individual is passed on to a gaining unit.

CHAPTER 7
★RADIOLOGICAL OPERATIONS OF A TACTICAL OPERATIONS CENTER ★(NATO STANAG 2103, ABCA SOLOG 123; NATO STANAG 2104, CENTO STANAG 2104, ABCA SOLOG 130; NATO STANAG 2112, SEATO SEASTAG 2112)

Section I. INTRODUCTION

7–1. General

★The supervision and coordination of the command radiological intelligence effort is part of the CBR mission of the tactical operations center (TOC) or comparable operations center. This supervision and coordination may be accomplished either by a chemical, biological, and radiological element (CBRE) or by the use of qualified personnel in the G2–G3 elements.

★*a. Purpose.* This chapter establishes the doctrine, techniques, and procedures to be used by personnel to perform the radiological part of the CBR mission of the command.

★*b. Applicability.* This chapter is written primarily for the CBRE of a division TOC.

★(1) The procedures are also applicable for the CBRE of a corps or field army TOC, for the area damage control center (ADCOC) of the field army support command (FASCOM), for the rear area operations center (RAOC) of support groups of FASCOM and theater army support command (TASCOM) or other rear area operations centers, and for the CBR center (element) team JA or JB.

★(2) This chapter is applicable in part to the radiological functions that are accomplished at brigade, battalion, and similar organizations. These functions are accomplished within S2 staff responsibility and are supported as necessary by control parties organized within the unit. At these headquarters, only a minimum of information processing is accomplished; the radiological functions are normally reduced to direction and control of the information collection effort and to the use of radiological intelligence produced by higher command echelons.

7–2. Assumptions

a. General. Guidance concerning the tactical impact of large-area contamination is based upon the following assumptions:

(1) The large-area contamination of most significance will be fallout which will decay at the standard rate and which can be related to a known nuclear burst.

(2) Neutron-induced hazards are expected to be of little significance within the limits of the discussion of paragraph 1–5*b*.

(3) Radiological agents will be used sparingly if at all.

b. Approach. Operational decisions based upon the assumptions of *a* above can be expected to be valid in most cases. The staff chemical officer exercises staff responsibility for determination of the validity of these assumptions with the CBRE representing his operational capability; thus, the CBRE must continually be alert to indications that the assumptions are not valid and be capable of functioning in special cases. For this reason, this chapter is written to provide a CBRE capability for any type of large-area contamination even though the more refined procedures such as calculated H-hour determination and nonstandard decay considerations will not be essential for most tactical applications.

7–3. Organization

a. Support. The command support required for the radiological intelligence collection effort is established by paragraph 1–11.

b. CBRE Capability. In order to accomplish the mission of supervision and coordination of the radiological intelligence effort, the CBRE must maintain a continuous capability to—

(1) Receive and transmit information.

(2) Perform computations necessary to convert basic information to the forms required for various calculations.

(3) Plot and display assembled information.

(4) Evaluate assembled information.

(5) Disseminate radiological intelligence.

c. CBRE Organization for Radiological Functions.

★(1) *Personnel.* For a 12-hour operation of a division CBRE, the personnel as delineated in the appropriate TOE include the CBRE chief or director, CBRE operations sergeant, computers, and plotters. When continuous 24-hour operations are required, these personnel must be supplemented by at least one CBR center (element) team JA or JB or preferably two JA teams.

(2) *Duties.*

(*a*) *The CBRE chief or director—*

1. Supervises and directs all functions of the CBRE, under the supervision of the chemical officer.

2. Analyzes incoming monitoring data to determine whether the radiological situation is described adequately and recommends a survey to the chemical officer if required.

3. Briefs survey parties on their specific missions when the primary or centralized method of control is used.

4. Analyzes incoming survey data and revises survey plans as required.

5. Directs the activities and movements of all survey parties which report directly to the CBRE control party.

6. Applies mathematical methods necessary to solve problems regarding unusual situations as they arise and prepares simplified tables or graphs as necessary for use by the computer and plotter in correcting data.

7. Maintains radiological situation map.

8. Disseminates radiological contamination data.

9. Maintains radiation status of subordinate and attached units.

(*b*) *The CBRE operations sergeant—*

1. Assists the CBRE director in the overall supervision of the CBRE.

2. Trains and cross-trains enlisted members of the CBRE.

3. Coordinates the functions of the enlisted members of the CBRE and monitors their output.

4. Insures accuracy in all functions by periodically checking the work of the computers and plotters.

5. Reviews all records, reports, maps, and sketches, prior to inspection by the CBRE director.

6. Monitors all information disseminated by the CBRE.

7. Assists in the controlling of radiological surveys.

(*c*) *The computer—*

1. Calculates transmission factors or correlation factors, as applicable, from data reported by survey parties or monitors.

2. Selects appropriate correction factors for decay from tables, graphs, or nomograms.

3. Converts all useful data to ground dose rates at a reference time by using the appropriate correlation factors.

4. Performs duties of the plotter as required.

(*d*) *The plotter—*

1. Plots data that have been corrected by the computer as necessary to obtain desired dose-rate contours.

2. Draws dose-rate contours from plotted data.

3. Performs entire task of making fallout predictions, using input data supplied.

4. Receives and records incoming survey and monitoring data as assigned.

5. Transmits instructions to survey parties and monitors as assigned.

6. Decodes and encodes messages as required.

7. Performs duties of the computer as required.

d. Cross Training. The number of individuals available for accomplishing the CBRE

radiological functions are normally limited, and the problems presented are varied and urgent. It is, therefore, essential that these personnel be cross-trained to perform all CBRE radiological functions.

★*e. Equipment.* The type of equipment required to conduct radiological functions may be found in the TOE of organizations authorized an organic CBRE or in TOE 3–500 and CTA 50–914.

Section II. CONCEPT OF OPERATIONS

7-4. General

Radiological contamination on the nuclear battlefield may cover large areas, may occur in many locations with overlap of contaminated areas, and may be in varying stages of standard or nonstandard decay. Initial detection of new contamination will probably be in the form of contact reports from units, patrols, or observers. These reports will alert the command to the presence of a previously undetected hazard and cause a new series of orders and requests to be initiated for radiological information. These orders and requests will be superimposed upon the radiological intelligence cycle that is already functioning for older contaminated areas. Thus, the supervision and coordination of the radiological intelligence effort will be a continuing process for the operations and control centers within the NBC reporting system organization of the field army.

7-5. Initial Requirements

In order to provide radiological intelligence as rapidly as possible, it is imperative that the CBRE obtain and maintain all possible information. Other units should obtain and maintain information as appropriate. These types of information are as follows:

a. Check Point Overlay. The check point overlay for aerial survey planning will be prepared as areas are assigned or as areas of interest change.

b. Wind Vector Plot. A current fallout wind vector plot will be maintained for fallout prediction.

c. Enemy Nuclear Capability. A summary of enemy nuclear capability will be maintained, if feasible, to assist in yield estimation.

d. Operation Map. An operation map showing area responsibility of major subordinate commands will be maintained for survey and monitoring planning purposes.

e. Nuclear Weapon Burst Record or Overlay. A record or overlay will be maintained showing as a minimum the location and time of burst and, if known, the yield and type of all bursts that have occurred within areas of interest.

f. Points, Routes, or Areas of Operational Interest. A listing or overlay showing points, routes, or areas where contamination could seriously affect accomplishment of the mission will be maintained for survey and monitoring planning purposes.

g. Equipment and Training Status. A record of equipment status and training status of available monitors, survey parties, and subordinate control parties will be maintained for survey and special report planning purposes.

h. Observation-Reporting Agencies. The locations of designated agencies for reporting nuclear bursts will be maintained up to date.

7-6. Sources of Contamination

The response of the intelligence cycle (FM 30-5) for developing data on areas of suspected contamination will depend upon the operational situation and upon the type and source of contamination. The operational situation will determine the urgency with which the cycle must function and the degree of detail which must be provided. The type and source of contamination will determine th' intelligence requirements and sequence of calculations to be performed. The types and sources of radiological contamination are as follows:

a. Induced Contamination. Contamination resulting from a nuclear burst where the contamination *can* be related to a specific nuclear burst where fallout did not occur, or contamination localized around an obvious ground zero area.

b. Fallout (Known Weapon). Contamination arriving or identifiable as fallout which *can* be related to a particular nuclear burst.

c. Fallout (Unknown Weapon). Contamination arriving or identifiable as fallout which *cannot* be related to a particular nuclear burst.

d. Contamination (Unknown Source). Contamination identifiable as induced, fallout, or radiological agent which *cannot* be related to a known source.

e. Combinations and Multiples of the Above.

7-7. Operation Procedure

a. General. The general concept of operations for the CBRE is that it acts as an evaluation agency through which all available CBR information is channeled. From this information, a CBR situation map showing areas of responsibility and interest will be developed and maintained. This map should contain all suspected, detected, and evaluated areas of radiological contamination and thus provide a basis for warning units and for development of required intelligence.

b. Information Flow. The information flow which provides the basis for accomplishing the evaluating function is established in paragraph 1-11. The automatic information flow will normally provide sufficient information to establish suspected areas of contamination. The CBRE will continually analyze this information so that timely warning can be provided to affected units and necessary procedures can be initiated to insure orderly and rapid development of knowledge about a particular contaminated area. Knowledge about a particular contaminated area should be developed so that classification of the contamination in the area will progress from "suspected" to "detected" to "evaluated" as described in paragraph 7-8. A summary of the types of information available which can be used to satisfy the requirements for analysis and development of information follows (see reports required in STANAG 2103 and STANAG 2104):

(1) *Automatic reports.*
- (*a*) Upper air wind data.
- (*b*) Nuclear burst reports.
- (*c*) Monitoring reports.

(2) *Other reports.*
- (*a*) Survey reports.
- (*b*) Series of monitoring reports.
- (*c*) Summary reports in specified areas of responsibility.
- (*d*) Verification reports at specified locations.

7-8. Classification of Contamination

a. Suspected Contamination. New contamination should be suspected to exist and the suspicion should be investigated under the following conditions:

(1) When a nuclear burst occurs.

(2) When contact reports indicate contamination in a previously unsuspected area.

b. Detected Contamination. Adequate warning of a contamination hazard to the command, particularly fallout warning, will require information indicating that contamination exists or is likely to occur and knowledge of the general area involved. Under the conditions indicated below, a contamination hazard is considered detected. This detection provides the basis for issuing a radiological contamination warning or a fallout prediction and for planning the collection effort necessary to evaluate the contamination hazard.

(1) A suspected neutron-induced contamination hazard is considered detected when monitoring or survey information indicates surface contamination localized around a ground zero area with no fallout formation. The arbitrary limit of a hazardous induced activity is established as the 2 rad/hr dose-rate contour determined at 1 hour after the burst (H + 1). The maximum horizontal radius of this dose-rate contour for yields of 1 MT or less at times later than 1 hour after burst is about 1,400 meters; it is usually substantially less, depending on the yield and height of burst of the weapon.

(2) A fallout contamination hazard is considered detected when nuclear burst reports indicate that fallout will probably occur from a nuclear burst (obvious surface burst), when observers report crater formation or extensive scouring, or when contact reports indicate fallout is actually occurring. The probable area that will be affected by fallout will be determined by a poststrike fallout prediction.

(3) Other radiological contamination hazards are considered detected when contact reports indicate the presence of the contamination hazard and monitoring reports, simplified survey, or reconnaissance indicate the general area affected.

c. Evaluated Contamination. Evaluation of a radiological contamination hazard may be considered sufficient when the following factors are known or reliably estimated:

(1) When the perimeter of militarily significant contamination is determined.

★(*a*) For new contamination (H-hour to H + 48 hours), this will be as specified in *b*(1) above for induced contamination; for fallout this will be the 1-hour after burst (H + 1) dose-rate contour of 20 rad/hr for short-term (24-hour) occupancy. The 10 rad/hr (H + 1) contour should be established locally, as required, for the purposes of estimating doses associated with long term occupancy of a contaminated area.

(*b*) For old contamination, greater than H + 48 hours, or for contamination of unknown age, the perimeter will be determined on the basis of conditions existing at the time. In the absence of specific guidance, the 1 rad/hr dose rate contour, at time of entrance into the area, will be used.

(2) When H-hour or a reference time is established.

(3) When the decay rate is known.

(4) When information about dose rates inside the perimeter is sufficient to make the dose calculations required for evaluation of the operational impact of the hazard.

7–9. Processing of Information

During the evaluation process, monitoring or survey reports will provide dose-rate information about the contaminated area. This dose-rate information must be converted to the ground dose rates existing at a reference time (normally H + 1 for all contamination except radiological agents). To accomplish processing and to calculate doses from the resulting intelligence, a reference time (H-hour) must be established and the decay rate of the contamination determined. The procedure to be followed in determining these two factors will depend upon the source of the contamination (para 7–6) and the operational situation existing at the time. In fast-moving division offensive operations, it is unlikely that detailed processing such as described in paragraphs 7–16 through 7–22 will be required. A rough estimation of H-hour and an assumption of standard decay will be sufficient to allow evaluation of a radiological contamination hazard for a 6- to 18-hour period. Detailed processing will later be required. A summary of the development of radiological contamination information as performed by the CBRE is presented below.

a. H-Hour Estimates.

(1) *Induced contamination (known weapon).* In the case of induced contamination from a known weapon, H-hour will be known and the decay of the contamination is assumed to be the same as type II soil until subsequent information enables the actual decay rate to be determined. Dose-rate information can be normalized to H + 1, a pattern prepared, and calculations made.

(2) *Fallout (known weapon).* In the case of fallout from a known weapon, H-hour will be known; the decay rate will be unknown but will be assumed to be standard ($n = 1.2$) until decay rate determination provides the actual decay rate. After monitoring reports indicate the cessation of fallout, immediate action must be taken to provide the data required to make a decay rate determination. Until this determination is actually made, it is emphasized that dose calculations and hazard evaluations are *estimates only,* and this information should be so identified.

(3) *Fallout (unknown weapon).* In the case of fallout from an unknown weapon, neither H-hour nor the decay rate will be known initially and they cannot be determined until monitoring information (para 7–13) is available, or laboratory facilities are available for analysis of the actual contamination. Analysis will become available to the CBRE in about 10 hours. Until the actual decay rate is determined, the decay rate will be assumed to be standard ($n = 1.2$). (See paragraph 7–19 for calculation of H-hour.)

(4) *Contamination(unknown source).* In the case of contamination from an unknown source, the procedure is the same as for (3) above.

(5) *Combinations and multiples of the above.* It is quite probable that contaminated areas on the nuclear battlefield will be recontaminated by new contamination; for example, fallout on fallout. Thus, the CBRE must be pre-

pared to identify combinations and multiples of the various forms of radiological contamination. Procedures for predicting future dose rates within areas of two or more overlapping contamination patterns are described in appendix G.

b. Plotting. As incoming information is processed, it is plotted on the radiological situation map by use of the procedures established in paragraphs 7–23 through 7–30.

c. Presentation and Dissemination. Normally reports of areas of contamination are disseminated as NBC 5 (nuclear) reports as prescribed in STANAG 2103 (app. C). For discussion of overlays, see paragraphs 7–31 through 7–34.

d. Maintenance of the Radiological Situation Map. Theoretically, once a radiological hazard has been identified, the contamination existing at any future time can be calculated. However, weathering and inaccuracies in initial identification make this approach unrealistic and frequent surveillance of contaminated areas is essential. The frequency and detail of the surveillance effort will be determined by the reliability of the initial identification. The surveillance effort will be planned and conducted as was the initial collection effort.

Section III. PLANNING

7–10. General

When a contaminated area has been detected, the CBRE must begin the planning process necessary to expand the collection effort for collection of the information required to evaluate the contamination hazard. Proper planning of this collection effort is essential to producing timely radiological intelligence.

7–11. Estimate of the Situation

a. There will be portions of the area of interest in which the troop density will be sufficient to insure that automatic monitoring reports will provide adequate dose-rate information. Therefore, the first step of the planning process will be to analyze the area of interest on this basis and then to estimate what additional information, if any, will be required for evaluation of the hazard. Concurrent with this analysis and based upon operational requirements, an estimate must be made of the time within which the hazard may be identified. An illustration of this process is shown in the example of *b* below.

b. During a division offensive operation a friendly weapon is employed as a surface burst at 0900 hours forward of the immediate division objectives. The fallout prediction indicates that the resulting contamination may lie across desired attack routes to objectives of the attack continuation and that fallout in this area may still be arriving until at least 1100 hours. The chemical officer, after coordination with the G2 and G3, indicates that no aerial reconnaissance missions are planned over the area of interest and that the contamination hazard in the area of interest (desired attack route) must be evaluated by 1300 hours to allow the division staff adequate time for formulation of plans. Based upon this information, the following assumptions can be made by the CBRE:

(1) Little or no information from the automatic reporting system can be expected about the contamination until friendly troops come in contact with the hazard.

(2) Required information about the contamination hazard on the desired attack route must be obtained and evaluated before 1300 hours.

(3) As much information as possible about the remainder of the contamination hazard is desirable before 1300 hours but, if necessary, an effort to obtain this information can be delayed until the contaminated area has passed under control of the division.

7–12. Survey Planning

a. General. The radiological survey plan for a contaminated area will be based upon the estimation of many variables and must establish as a minimum the amount of detail required, method of control (decentralized or centralized), type of survey (ground or air), and technique to be used (route, point, course leg, or preselected dose rate). The survey plan for a particular contaminated area will probably contain a combination of these methods,

types, and techniques. For example, a typical daylight survey of a contaminated area may include a centralized and a decentralized ground survey combined with a centralized aerial survey, where each covers a different zone within the contaminated area, and all the techniques may be employed.

b. Factors Affecting the Plan. Some of the many variables affecting the survey planning function, with guidance concerning their major effects, are listed below. In the preparation of the survey plan, each of these factors must be estimated and balanced against the need for information.

(1) *Knowledge of the contamination.* Knowledge about the contaminated area which is available or expected to be available (such as monitoring reports) will determine the size of the area to be surveyed and the amount of detail required.

(2) *Operational situation.*

(*a*) In rapidly changing situations, centralized control may be necessary.

(*b*) Under the conditions in (*a*) above, aerial survey is desirable but ground survey may be required for critical routes such as main supply routes and counterattack routes.

(*c*) The operational situation will dictate the availability of personnel and equipment.

(3) *Urgency.* Centralized aerial survey is normally the most rapid means of obtaining information.

(4) *Weather.* Aerial survey may be precluded by poor visibility. Surveys should be delayed, if possible, during precipitation and high winds as these conditions tend to change a contamination pattern.

(5) *Time of survey.* Detailed ground surveys normally can be accomplished any time, whereas aerial surveys will be limited primarily to daylight hours.

(6) *Terrain.* The road nets and the ability of the soil to support ground movement may determine the use of ground survey. Aerial survey is of limited use in mountainous terrain. In areas (arctic, desert, jungle) where reference points are rare, marking may be required and the type of survey must be carefully selected.

(7) *Status of training.* Inadequate training or losses of trained personnel may limit survey capability. The status of training must be considered in selection of the type of survey. Status of training of control parties at subordinate headquarters will affect the method of survey (centralized or decentralized).

(8) *Time-distance.* Time-distance factors must be estimated and considered when selecting the type of survey most appropriate to obtain and allow evaluation of required information within established time limits. Generally, required information for tactical planning cannot be determined until fallout has ceased. Aerial survey operations should not be initiated until fallout has ceased. Dependence upon monitoring reports is the primary method of obtaining a rough estimate of contamination information during fallout.

(9) *Dose.* Dose status of survey personnel and the operation exposure guide set by the commander must be evaluated when planning the type of survey.

(10) *Communications.* Availability of communications facilities will affect all phases of the survey plan. Centralized aerial survey will normally impose the least communications load.

(11) *Maps.* The CBRE must consider the maps, and the areas they cover, available to units that will participate in the survey.

7–13. Special Reports Requirements

a. General. Based upon an estimate of the situation (para 7–11) which includes the factors of paragraph 7–12, additional information required must be requested as special reports. Some of the requirements that may necessitate special reports are discussed in detail below.

b. Points, Routes, or Areas of Operational Interest. Some points, routes, or areas within a detected contamination hazard area may be of particular operational interest and thus may require more urgent, detailed, or precise information than the remainder of the hazard area. Requirements for additional informa-

tion in the contaminated area should be established by appropriate staff officers in coordination with the chemical officer. Special monitoring or survey missions may be necessary to satisfy these requirements. Examples of points, route, or areas about which additional information might be required are ammunition or other vital supply points, main supply routes, proposed attack or counterattack routes, assembly areas, and critical observation posts.

c. Dose-Rate Determination. If an estimate of the situation in accordance with paragraph 7–11 indicates that available ground dose-rate information will be insufficient for required dose calculations, radiological survey or special monitoring reports will be required.

d. H-Hour Determination. In those cases where a detected radiological hazard cannot be related to a specific nuclear burst, special monitoring reports will be required to determine H-hour. Information necessary to determine H-hour is obtained from a series of monitoring reports from several selected locations. When these series of monitoring reports are required, each dose rate must be taken with the radiacmeter placed at the same position within the selected location. Generally, each of these series should consist of at least six reports spaced over at least a 2½-hour period, followed by a series of hourly reports. The locations at which these series of readings should be taken are carefully selected by the CBRE, based upon the length of time a unit is likely to remain in its present location and the status of training of the unit. The locations should be selected so that the soil, vegetation, and other general features of the area are typical of the contaminated area. Further development of information depends upon the H-hour determination; therefore, it is essential that these series of monitoring reports be properly and promptly accomplished with the information precisely determined.

e. Decay-Rate Determination. The decay rate of the contamination should be determined for making a more accurate evaluation of the hazard. For induced contamination, the soil type, known or assumed (type II), will determine the decay rate. For fallout, the assumed decay rate (n = 1.2) is used until a series of monitoring reports as described in *d* above provides sufficient data for the valid determination of the actual decay rate.

7–14. Decentralized Survey

The CBRE may request that a subordinate unit be directed to conduct a survey. For example, division may direct a brigade to perform a survey of some sector or all of the brigade area. The brigade control party plans and conducts the survey. This control party will plan the survey, brief and direct the survey parties, receive and check the data for completeness and validity, and transmit the data through proper channels to the division CBRE.

7–15. Survey Party Briefing

Adequate control of the radiological survey, once the survey plan has been initiated, will depend to a large extent upon proper briefing of the survey parties. Survey party briefings may vary from group to individual briefings, depending upon space, time, and operational conditions; briefings may be given in oral, written, overlay, or other form. In any case, a briefing should always be conducted. The written or oral briefing is essentially an order and should follow generally the form of the 5-paragraph operation order as shown in table 7–1 (also see para 6, STANAG 2112).

Table 7–1. Radiological Survey Party Briefing Order

Reference list. List any maps, charts, or other documents necessary to understand the order.

1. SITUATION

a. Operational Situation. Briefly describe the operational situation as it concerns conduct of the survey, to include enemy forces, friendly forces, and planned actions.

b. Contamination Situation. Present any factual information available about the contaminated area, to include limits, dose rates, source of contamination, terrain, and weather.

2. MISSION

Clear, concise statement of task to be accomplished (who, what, when, where, and why).

3. EXECUTION

a. Concept of Operation.

b. Specific Assignment of Each Party. In subsequent separate lettered subparagraphs (such as *c, d, e*), give the specific task of each survey party. Include the coordination required.

Table 7-1—Continued.

c. Coordinating Instructions. The last subparagraph of paragraph 3 of the order contains instructions applicable to two or more of the survey parties, such as:

(1) Time of departure and return.

(2) Routes and alternate routes to and from the contaminated area.

(3) Coordination required.

(4) Dose or dose rate danger limitations (for example, turnback dose-rate and operation exposure guide).

(5) Actions to be taken upon reaching limitations in (4) above.

(6) Whether and when marking of contaminated areas is required.

(7) Debriefing—where, when, by whom.

4. ADMINISTRATION AND LOGISTICS

Contains information such as required equipment and forms.

5. COMMAND AND SIGNAL

a. Signal.

(1) Survey reporting procedure.

(2) Index and issue number of the signal operation instructions (SOI) in effect.

(3) Call signs, code to be used, and reporting times.

(4) Communications means (primary and alternate).

b. Command. Location of control party.

Section IV. CALCULATION PROCEDURES

7-16. General

The calculations contained in this section represent the most detailed processing capability of the CBRE in its performance of the radiological functions. The extent to which these various information processing calculations will be used will depend to a considerable degree on the operational situation existing at the time a hazard is being evaluated (para 7-12*b*(2)) and upon the need for a detailed evaluation of the particular hazard.

7-17. Time of Completion of Fallout

An *estimate* of the time when fallout will be essentially completed at a particular location may be made by the mathematical procedure given in *a* below. Subparagraph *b* below describes the method of determining the time fallout actually ceased at a particular point.

a. Mathematical Estimate. The time (T) in hours after detonation by which fallout will be completed at any specified point is approximately one and one-quarter the time of arrival (in hours after detonation) of fallout plus the time in hours required for the nuclear cloud to pass over. This is expressed by the formula:

$$T_{completion} = 1.25 \times T_{arrival} + \frac{\text{cloud diameter}}{\text{effective wind speed}}$$

Determinations of time of arrival, cloud diameter, and effective wind speed are discussed in TM 3-210.

Example. For a particular location, the following data have been determined:

$T_{arrival} = H + 2$ hr.

Cloud diameter = 4 km.

Effective wind speed = 20 kmph

$$T_{completion} = 1.25 \times 2 \text{ hr} + \frac{4 \text{ km}}{20 \text{ kmph}}$$

$$= 2.5 + .2 = 2.7 \text{ hr.}$$

Thus, at points where time of arrival of fallout is H + 2 hours, fallout should be completed by H + 2.7 hours.

b. Observation of Monitoring Data. The time of actual completion of fallout may be determined by taking a series of dose-rate readings at the same location and in the same manner over a period of time. The dose rates should be plotted against time on log-log paper. The dose rates should get larger, reach a maximum, and then start to get smaller with time. Sufficient points should be plotted until the points fall on the same straight line (indicating that the decay is constant). Then the time of cessation of fallout can be determined by noting the time of the highest dose rate reading on the straight line depicting constant decay (para 7-18*b* and *d*).

7-18. Determination of Decay Rate (H-Hour Known)

a. Kaufman Equation. Fallout will decay according to the following equation:

$R_1T_1^n = R_2T_2^n$,

where:

R = dose rate at a location,
T = time in hours after H-hour,
n = decay exponent, and
1 and 2 are subscripts denoting different times after H-hour.

★When 1 denotes H + 1 and 2 denotes any other time, the equation becomes $R_2 = R_1 T_2^{-n}$.

b. Decay Rate. Dose calculations and pattern evaluations depend upon knowledge of the rate at which the contamination is decaying; thus, the decay exponent must be known. In fallout contamination, the value of *n* will not necessarily be constant with time or even constant throughout a particular contaminated area although the pattern as a whole will have an average value. This average value will vary from pattern to pattern.

***Caution:* When dealing with overlapping contaminated patterns, using an "average" n value for the overall pattern can lead to serious error. See appendix G.**

The amount of variation is expected to be from about 0.8 to 2.0 for fallout; lower values of *n* can be expected for radiological agents or salted* weapons. The average value of *n* for most patterns will be 1.2, which is referred to as standard decay. Standard decay may be assumed when decay-rate estimation or determination cannot be made, but the decay rate for any fallout pattern should be determined whenever possible.

c. Decay-Rate Determination or Estimation (H-Hour Known). The determination or estimation of decay rate depends upon knowledge of H-hour and may be accomplished graphically or mathematically as shown in *d* and *e* below. For either method, a series of dose-rate readings from several selected locations are required (para 7–13*e*). The reliability of the decay-rate calculation is directly related to the precision of the dose-rate readings, to the length of the time interval over which the readings were taken, and to the length of time over which dose calculations are to be made. That is, the more reliable the monitoring dose-rate readings and the longer the time interval over which they are taken, the longer the time period over which reliable dose calculations can be made. As a reule of thumb for decay-rate determination, reliable dose calculations can be projected in time (T_p) over a period three times as long as the monitoring time interval. For example, for a decay rate determined from monitoring readings taken between H + 4 and H + 8, dose calculations could be reliably projected from H + 8 to H + 20 (T_p = H + 8 + [3 (8–4)] = H + 20). An illustration of the way in which decay-rate determinations and estimations are used in developing a contamination pattern is given below.

Example. Consider a fallout-producing nuclear burst (H-hour known) with the collection effort initiated at H + 4 and expected to be completed by H + 6; the target time for preparation of the pattern is H + 8. By H + 4 to H + 6, a decay estimation can be made and used to process the remainder of the dose-rate information from the collection effort. This procedure will result in a reasonably reliable H + 1 pattern. By H + 6, a decay-rate determination can be accomplished which will allow use of the resulting pattern until about H + 12. By H + 12, a decay-rate determination can be accomplished which will allow use of the pattern until H + 36 hours.

d. Graphical Method for Determination of n. When a series of dose rates from one location is plotted on log-log graph paper, the decay rate of the contamination will cause the line plotted to be a straight line, inclined at a slope (*n*) to the axes of the graph.

Example. Suppose the set of readings shown below is received for decay-rate determination; H-hour is known or determined to be 0930 hours.

Time of reading	1000	1030	1100	1130	1200
Location	Dose rate (rad/hr)				
A	40	21	14	11	9
B		12	8	6	5
C			79	60	50

When these data are plotted on log-log graph paper, using the time as the number of hours past H-hour, and the best possible set of three lines is drawn through the points, the graph

*Weapons containing specific nuclides which will change the composition of fallout (see para 9.11, DA Pam 39–3).

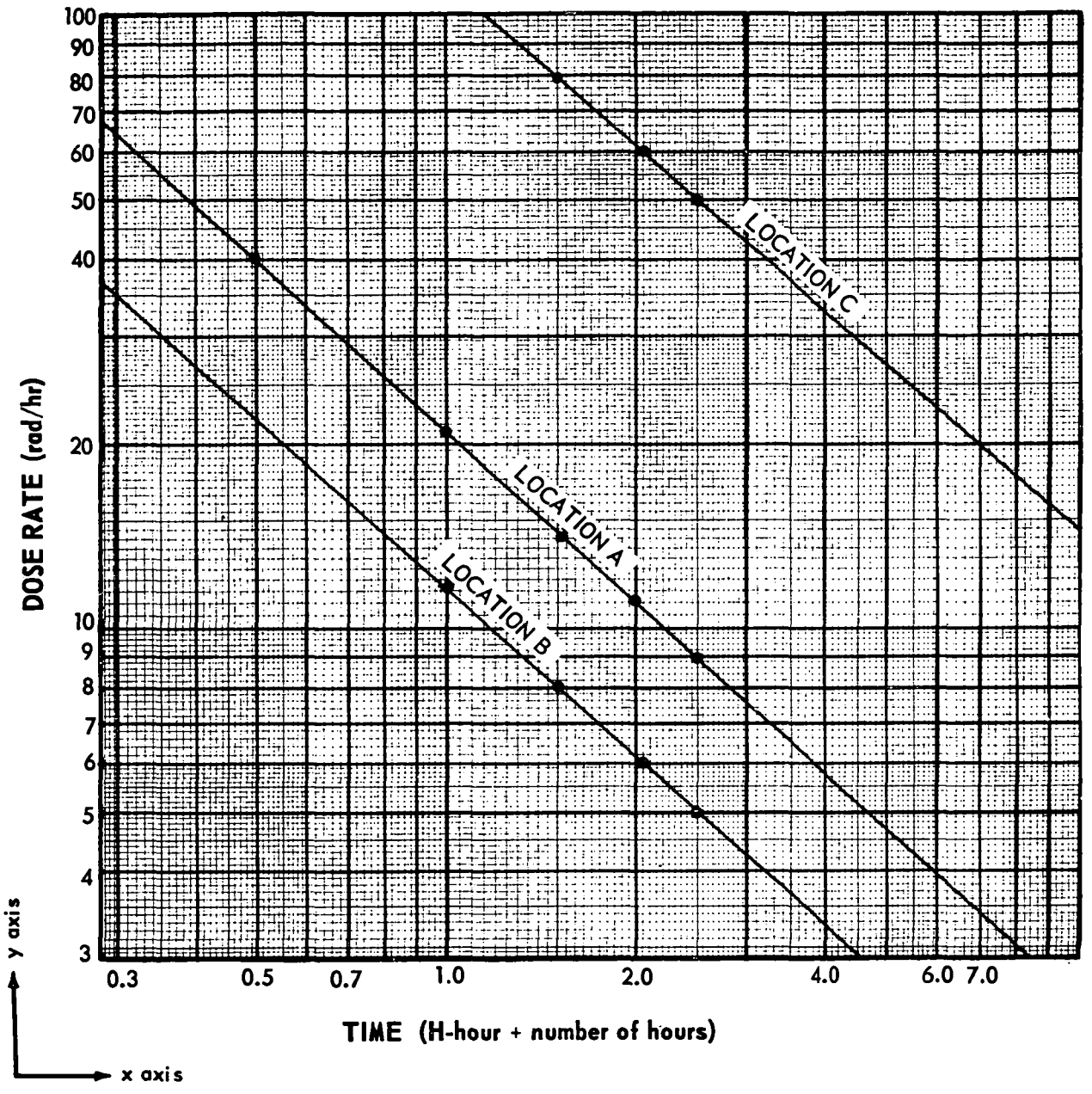


Figure 7-1. Decay-rate determination (monitoring reading plot).

shown in figure 7-1 is obtained.* The slope of these three parallel lines is n, the decay exponent. A linear scale is superimposed on the graph as illustrated in figure 7-2 to show the determination of linear measurements. The value of n may then be determined for each location and an average n determined as shown below.

$$n_C = \frac{{}^{y}C1 - {}^{y}C2}{{}^{x}C1 - {}^{x}C2} = \frac{9.0 - 6.0}{9.2 - 5.9} = 0.91$$

*It is pointed out that this is an example to demonstrate a procedure. In actual practice the points will not likely fall exactly on a straight line as in figures 7-1 and 7-2. In actual practice, the best straight line is fitted to the points.

$$n_A = \frac{{}^{y}A}{{}^{x}A} = \frac{8.8}{9.6} = 0.92$$

$$n_B = \frac{{}^{y}B}{{}^{x}B} = \frac{6.8}{7.6} = 0.89$$

$$\text{Average } n = \frac{0.91 + 0.92 + 0.89}{3} = \frac{2.72}{3} = 0.91$$

e. Mathematical Method for Determination of n. The formula for the mathematical determination of the decay exponent is found by solving the Kaufman equation (*a* above) for *n*.

$$\text{Thus, } n = \frac{\log\left(\frac{R_1}{R_2}\right)}{\log\left(\frac{T_2}{T_1}\right)}$$

Apply the monitoring data to this formula, using end point dose rates as shown below.

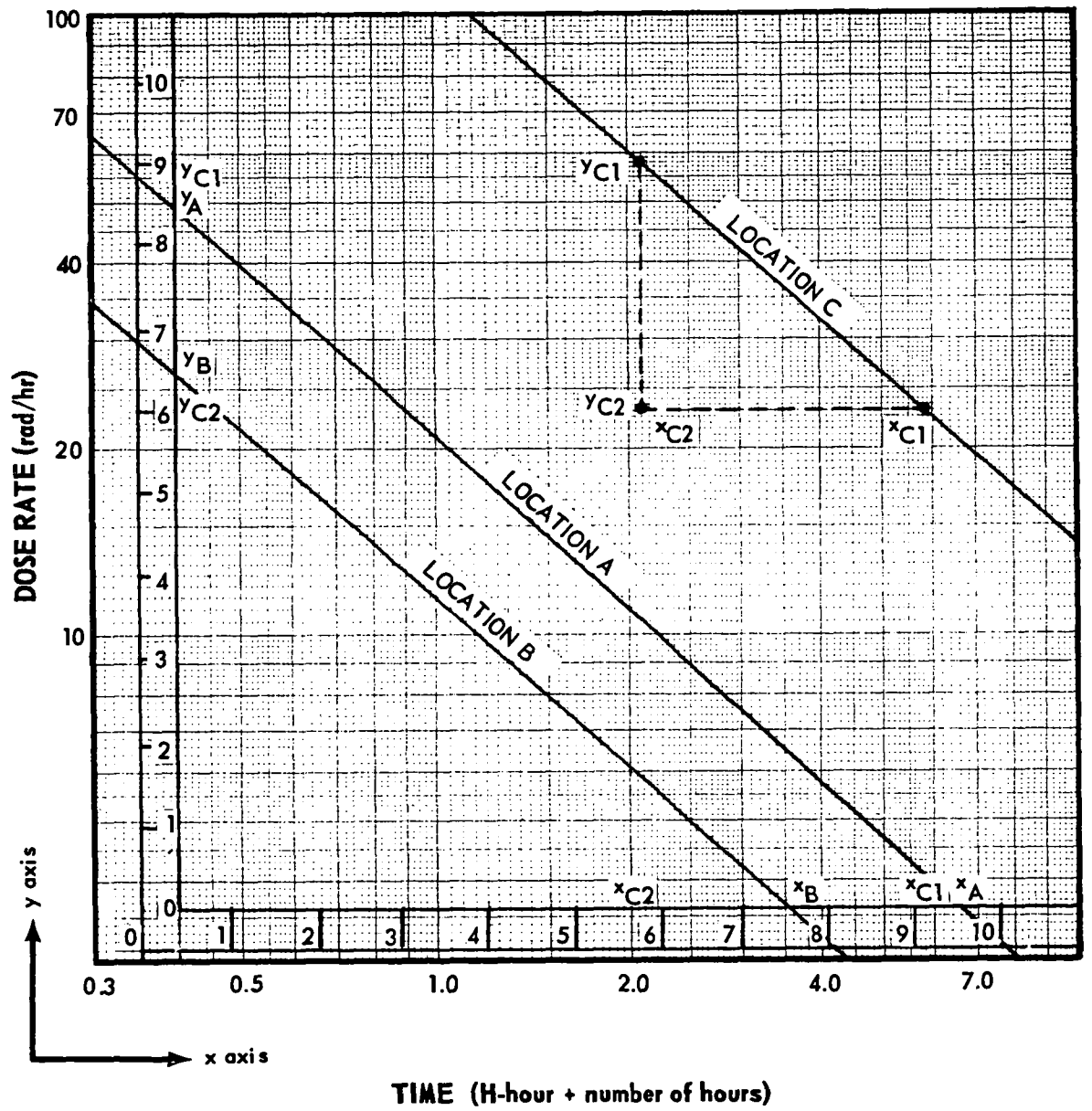


Figure 7-2. Decay-rate determination (measurement of slope).

Location A.

$$n = \frac{\log\left(\frac{40}{9}\right)}{\log\left(\frac{2.5}{0.5}\right)} = \frac{\log (4.44)}{\log (5)} = \frac{0.647}{0.699} = 0.926$$

Location B.

$$n = \frac{\log\left(\frac{12}{5}\right)}{\log\left(\frac{2.5}{1}\right)} = 0.955.$$

Location C.

$$n = \frac{\log\left(\frac{79}{50}\right)}{\log\left(\frac{2.5}{1.5}\right)} = 0.896$$

$$\text{Average } n = \frac{0.926 + 0.955 + 0.896}{3}$$

$$= \frac{2.777}{3} = 0.926 = 0.93.$$

7–19. Calculation of H-Hour

a. Mathematical Calculation of H-hour. H-hour may be calculated using the following procedure:

$$T_1 = \frac{T_b - T_a}{\left(\frac{R_a}{R_b}\right)^{\frac{1}{n}} - 1}$$

where:

T_1 = time after H-hour shot at which reading R_a was made, and $T_b - T_a$ = interval between readings R_a and R_b.

The value of $\left(\frac{R_a}{R_b}\right)^{\frac{1}{n}}$ can be calculated or may be read from a family of curves (fig. 7–3). This calculational procedure can be made by using an assumed decay exponent or one that has been determined experimentally. For example:

(1) Suppose monitoring reports R_a and R_b represent the earliest and latest data available for a particular location within the contaminated area.

R_a = 112 rad/hr (0500 hours, 15 January)

R_b = 24 rad/hr (2200 hours, 15 January)

Then:

$$T_1 = \frac{17 \text{ hours}}{(4.67)^{\frac{1}{n}} - 1}$$

(2) From figure 7–3, assuming n = 1.2:

$$T_1 = \frac{17 \text{ hours}}{3.6 - 1} = 6.54 = 6.5 \text{ hours.}$$

(3) Since T_1 is the time after H-hour at which reading R_a was made, then H-hour = $T_a - T_1$ = 0500 hours, 15 January −6.5 hours
= 2230, 14 January.

b. Use of ABC–M1 Radiac Calculator to Determine H-Hour. The ABC–M1 radiac calculator may be used in lieu of the above mathematical procedure to determine H-hour as follows:

(1) Choose two readings, for example, the first and last readings made at a particular location.

Time	*Dose Rate*
1600 hours	50 rad/hr
1830 hours	40 rad/hr

Locate the two dose rates on the outer disk. Determine the time interval between the two readings—

Time interval = 2½ hours.

(2) Move the intermediate disk until a time interval of 2½ hours coincides with the 40 and 50 rad/hr readings on the outer disk (fig. 7–4). Read the time under the 50 rad/hr as 12 hours. The 50 rad/hr dose rate was read at 1600; thus, 1600 hours corresponds to H + 12. This means that H-hour was 12 hours earlier than 1600.

H-hour = 1600 − 1200 = 0400 hours.

Note. This calculation is made assuming standard decay (n=1.2).

7–20. Correlation Factor

Monitoring and survey dose-rate readings that

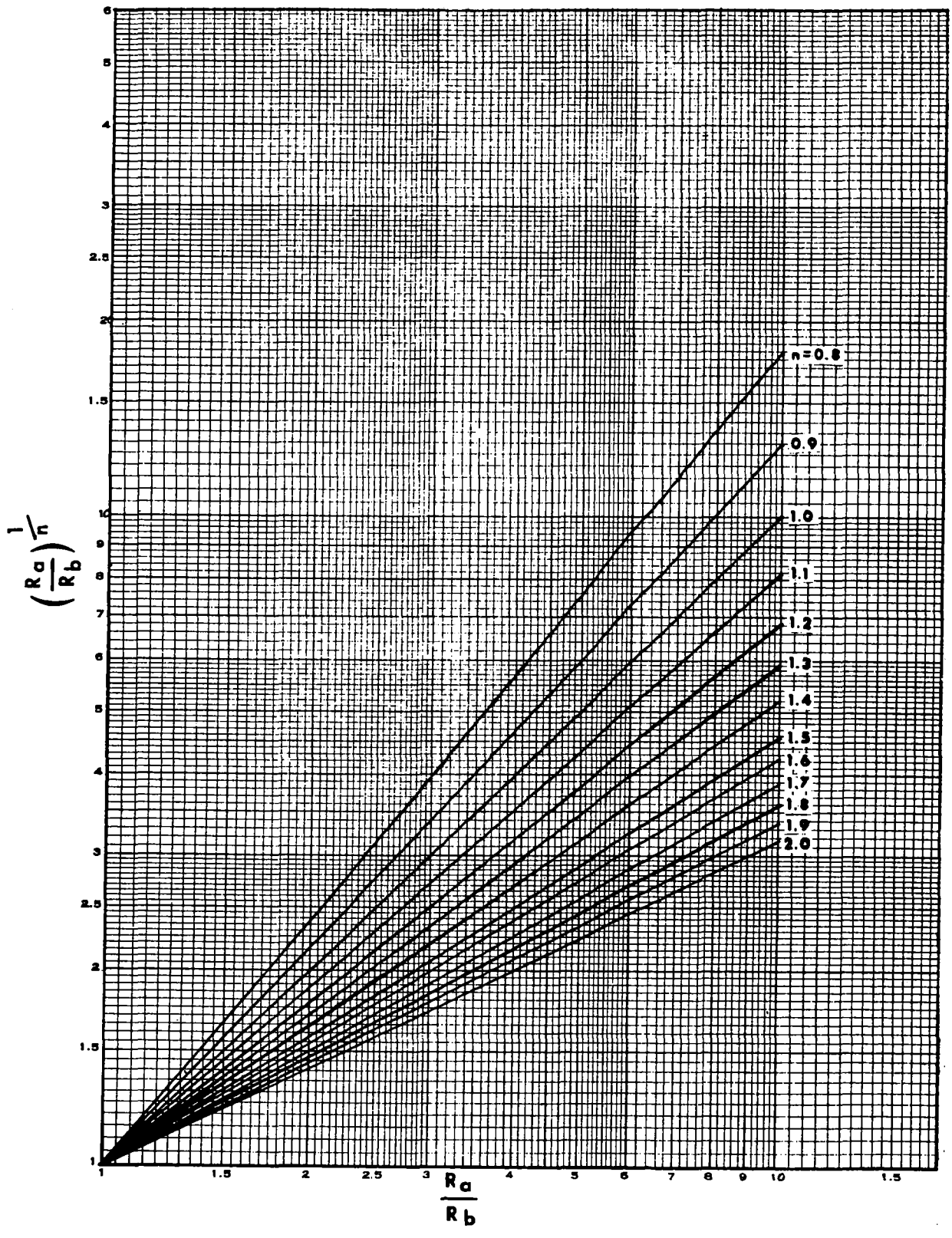
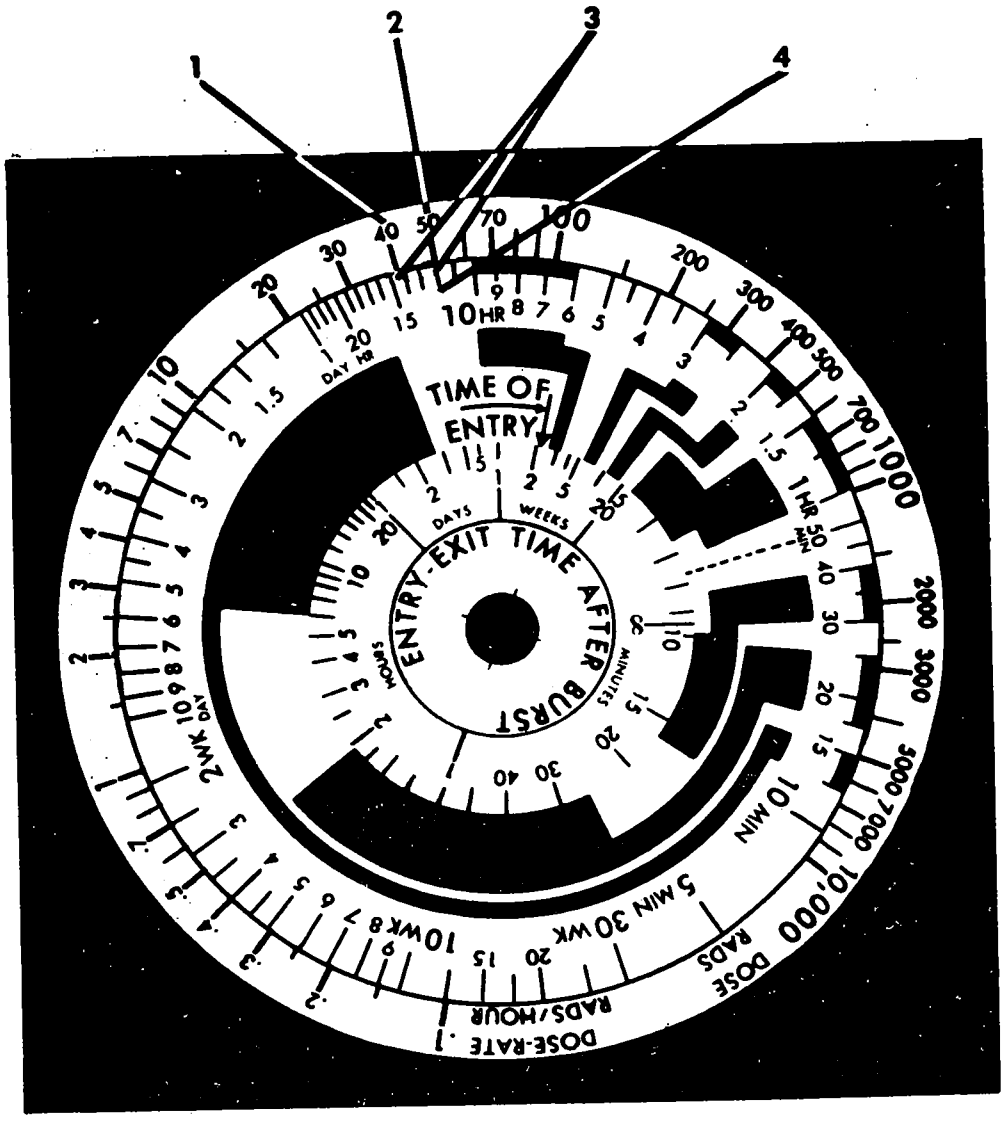


Figure 7-8. Value of $\left(\frac{R_a}{R_b}\right)^{\frac{1}{n}}$



1. 40 rad/hr on outer disc.
2. 50 rad/hr on outer disc.
3. 2½-hr interval on intermediate disc.
4. Reading of 12 hrs.

Figure 7-4. Determination of H-hour using the ABC-M1 calculator.

are taken in a shielded position must be converted to unshielded ground dose-rate readings. A multiplying factor used to accomplish this conversion is called a correlation factor. Space is provided on the radiological data sheets for both the required dose-rate information and the calculation of the correlation factor. If correlation factor data are not pro-

vided, but only the type of shielding is provided, correlation factors may be obtained from figure 4-4 or table 4-2.

7-21. Normalizing Factor

The normalizing factor (NF) is the ratio of the ground dose rate at a reference time to the ground dose rate at any other known time after the completion of fallout in the area of interest, or

$$NF = \frac{\text{ground dose rate at a reference time}}{\text{ground dose rate at any other known time}}$$

Normalizing factors may be found mathematically or graphically, or may be taken from a table of values. Each method is described below.

a. Mathematical Method. The Kaufman equation, $\frac{R_1}{R_2} = \left(\frac{T_2}{T_1}\right)^n$, is used in determining the normalizing factor by the mathematical method, where subscript 1 denotes the reference time and subscript 2 denotes any other known time at which a dose rate is determined. Thus, since $NF = \frac{R_1}{R_2}$ and, since, $\frac{R_1}{R_2} = \left(\frac{T_2}{T_1}\right)^n$, it follows that $NF = \left(\frac{T_2}{T_1}\right)^n$. When the reference time is H + 1, $(T_1)^n = 1$ and $NF = (T_2)^n$.

b. Table of Values. Table 7-2 is a table of normalizing factors for selected times after a nuclear burst and for various decay exponents. The reference time in this table is H + 1. This table is normally used when H-hour is known for fallout contamination and the collection effort is initiated immediately.

Example. The collection effort has been initiated and H-hour has been determined to be 0800 hours. It is now 1130 hours and a dose-rate report of 150 rad/hr has been received from location A. What is the R_1 (H + 1) dose rate if the decay exponent is 1.2?

SOLUTION. From table 7-2, find the normalizing factor for a decay exponent of 1.2 when the time after burst is 3 hours and 30 minutes.

$$NF = \frac{R_1}{R_2}$$

or,

$$R_1 = NF \times R_2$$
$$= 4.5 \times 150 \text{ rad/hr}$$
$$= 675 \text{ rad/hr.}$$

c. Graphical Method. The graphical method of determining the normalizing factor is based on the fact that a plot on log-log graph paper of normalizing factor versus the ratio of time after burst at which a reading is taken to desired reference time is a straight line. This method is used when it is desired to determine a large number of normalizing factors for normalizing to a time other than H + 1 (that is, table 7-2 cannot be used) or to extend the time scope of table 7-2. The procedure below requires that both n and H-hour be known. (If either is known, the other can be calculated by procedures in paragraph 7-18 or 7-19.)

(1) Calculate the normalizing factor for the earliest and latest monitoring data available for a particular location, using the formula

$$NF = (T_2)^n$$

if the desired reference time is H + 1, or

$$NF = \left(\frac{T_2}{T_1}\right)^n$$

for any other desired reference time.

(2) Plot these two calculated NF values on log-log graph paper against T_2 if the desired reference time is H + 1, or against T_2/T_1 for any other desired reference time.

(3) Connect the two points on the graph by a straight line and extrapolate the straight line to later or earlier times as required.

(4) For any value of T_2 (or T_2/T_1 if the reference time is other than H + 1), read the corresponding value for NF from the graph.

7-22. Overall Correction Factor

The overall correction factor (OCRF) is the product of the correlation factor (CF) and the normalizing factor (NF). The calculation of this factor greatly reduces the work required

★*Table 7–2. Normalizing Factors (Correction to H + 1 hr)*

Time after burst	Decay exponent (n)							
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
10 min	0.341	0.238	0.167	0.116	0.081	0.057	0.040	0.028
20 min	0.517	0.415	0.333	0.268	0.215	0.172	0.138	0.111
30 min	0.660	0.574	0.500	0.435	0.379	0.330	0.287	0.250
40 min	0.784	0.723	0.667	0.615	0.567	0.523	0.482	0.444
50 min	0.896	0.864	0.833	0.803	0.775	0.747	0.720	0.694
1 hr 0 min	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1 hr 10 min	1.09	1.13	1.16	1.20	1.24	1.28	1.32	1.36
1 hr 20 min	1.18	1.25	1.33	1.41	1.49	1.58	1.67	1.77
1 hr 30 min	1.27	1.38	1.50	1.62	1.76	1.91	2.07	2.25
1 hr 40 min	1.35	1.50	1.66	1.84	2.04	2.26	2.50	2.77
1 hr 50 min	1.43	1.62	1.83	2.07	2.33	2.63	2.97	3.36
2 hr 0 min	1.51	1.74	2.00	2.29	2.63	3.03	3.48	4.00
2 hr 15 min	1.62	1.91	2.25	2.64	3.11	3.66	4.30	5.06
2 hr 30 min	1.73	2.08	2.50	3.00	3.60	4.33	5.20	6.25
2 hr 45 min	1.83	2.24	2.75	3.36	4.12	5.04	6.17	7.56
3 hr 0 min	1.93	2.40	3.00	3.73	4.65	5.80	7.22	9.00
3 hr 15 min	2.02	2.56	3.25	4.11	5.20	6.59	8.34	10.56
3 hr 30 min	2.12	2.72	3.50	4.49	5.77	7.42	9.53	12.25
3 hr 45 min	2.21	2.87	3.75	4.88	6.36	8.28	10.79	14.06
4 hr 0 min	2.29	3.03	4.00	5.27	6.96	9.19	12.12	16.00
4 hr 20 min	2.41	3.23	4.33	5.81	7.79	10.44	14.00	18.77
4 hr 40 min	2.52	3.42	4.66	6.35	8.64	11.76	16.00	21 77
5 hr 0 min	2.62	3.62	5.00	6.89	9.51	13.13	18.11	25.00
5 hr 20 min	2.73	3.81	5.33	7.45	10.41	14.56	20.35	28.44
5 hr 40 min	2.83	4.00	5.66	8.01	11.34	16.04	22.69	32.11
6 hr 0 min	2.93	4.19	6.00	8.58	12.28	17.58	25.15	36.00
6 hr 20 min	3.02	4.37	6.33	9.16	13.25	19.17	27.72	40.11
6 hr 40 min	3.12	4.56	6.66	9.74	14.23	20.80	30.41	44.44
7 hr 0 min	3.21	4.74	7.00	10.33	15.24	22.49	33.20	49.00
7 hr 20 min	3.30	4.92	7.33	10.92	16.27	24.23	36.10	53.77
7 hr 40 min	3.39	5.10	7.66	11.52	17.31	26.02	39.11	58.77
8 hr 0 min	3.48	5.27	8.00	12.12	18.37	27.85	42.22	64.00
9 hr 0 min	3.73	5.80	9.00	13.96	21.67	33.63	52.19	81.00
10 hr 0 min	3.98	6.31	10.00	15.84	25.11	39.81	63.09	100.00
11 hr 0 min	4.21	6.80	11.00	17.76	28.70	46.36	74.90	121.00
12 hr 0 min	4.44	7.30	12.00	19.72	32.42	53.29	87.60	144.00

to calculate the final data to be plotted. Instead of multiplying each monitoring and survey reading by the CF and then the NF, each reading is multiplied by the OCRF only. The overall correction factor is calculated as OCRF = CF × NF.

Section V. PLOTTING RADIOLOGICAL CONTAMINATION DATA

7–23. Plotting Requirements

The radiological situation map shows only the minimum essential information about detected and identified areas of contamination necessary to allow visual interpretation of the contamination situation. Each contaminated area is depicted on the map by a pattern of dose-rate contour lines and a few key dose rates for points, routes, or areas of particular concern. This information is developed by plotting monitoring and survey dose-rate information which has been corrected to unshielded ground dose rates at the reference time (normally H + 1) for the particular pattern. All monitoring and survey information for a contaminated area is eventually plotted as ground dose rates. These dose-rate plotting procedures are discussed in paragraphs 7–24 through 7–27. Plotting procedures to develop contour lines and key dose rates are established in paragraphs 7–28 through 7–30.

7–24. Worksheet Overlay

Determination of dose-rate contours and key dose-rate locations requires large quantities of dose-rate information. Once the contours and key dose rates have been determined, however, much of the dose-rate information would be extraneous on the radiological situation map. For this reason, worksheet overlays are prepared for the initial identification and surveillance of each contamination hazard and only the necessary identification data are transferred to the radiological situation map.

7–25. Single Point Dose Rates

Monitoring reports and ground and aerial survey reports from those parts of the survey accomplished using point techniques are directly processed and plotted into ground dose rates at the points at which the readings were taken.

7–26. Route Techniques

a. Ground Survey. Dose-rate information from a ground survey accomplished using the route techniques will be processed into normalized ground dose rates which existed at selected distance intervals along a route between two or more checkpoints. The route, checkpoints, and distance interval will be determined prior to the survey. The plotting procedure established in (1) and (2) below can be accomplished prior to receipt of the survey information.

(1) Mark and label the checkpoints on the worksheet overlay and trace out the preselected routes.

(2) Divide the route between checkpoints into the preselected distance intervals, moving in the same direction as that assigned the survey party.

(3) Enter the normalized dose rate beside the proper location as processed data become available.

b. Aerial Survey. Dose-rate information from an aerial survey which was flown using the route technique will be processed into normalized ground dose rates which existed at certain points along the route and plotted as shown below.

(1) Before receiving the dose rate information, mark and label the checkpoints for the route on the worksheet overlay and trace out the preselected route.

(2) After the survey data for the route are received, count the number of readings taken for the route. Care must be taken to include all readings, including zero readings, since the number of time intervals used during flight of the route is required. Since the aircraft flew over the route at a constant ground speed taking readings at equal time intervals, the distance covered between any two consecutive readings will be the same. Thus, if the route is divided into a number of equal length segments

where the total number of segments is equal to the number of time intervals, each division point on the route will represent a location over which a dose-rate reading was taken. The interval between readings is equal to the length of the course leg or route divided by the number of readings less one.

$$\text{interval} = \frac{\text{length of course leg (route)}}{\text{numbers of readings} - 1}$$

For example, figure 7–5 shows the points along route (1) to (2) over which readings were taken. In this case, 7 readings were taken but the route is divided into only 6 (6 = 7–1) segments. Therefore, divide the route into a number of equal length segments equal to one less

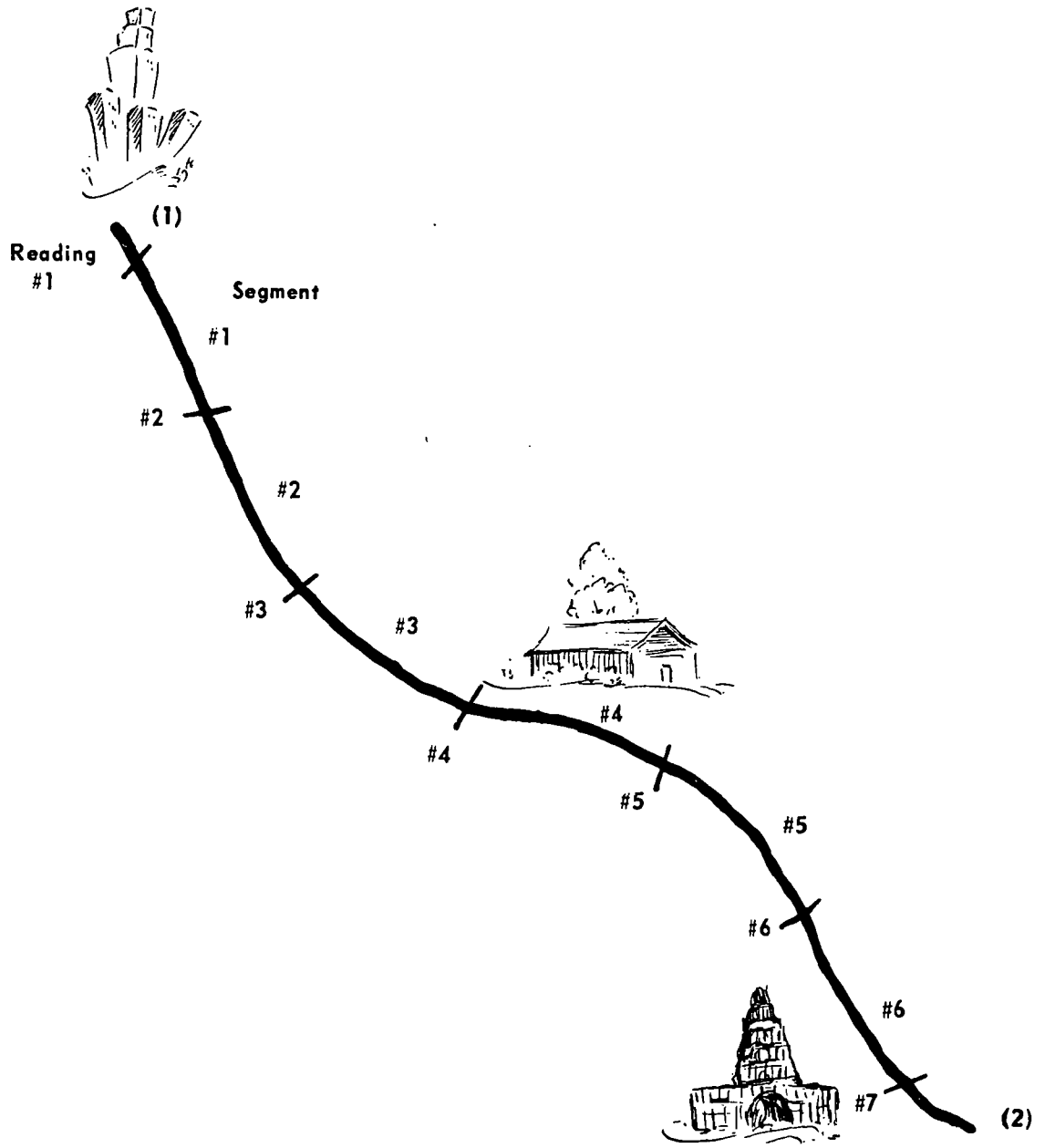


Figure 7–5. Plotting aerial survey (route technique).

than the number of readings taken by the survey party.

(3) Post the normalized dose rates on the worksheet overlay beside the location point for the route as the dose-rate readings are processed.

7-27. Aerial Survey Course Leg Technique

Dose-rate information from an aerial survey conducted by the course leg technique is plotted, using the same procedure as that established in paragraph 7-26*b*. The only difference between the two techniques is that in the route technique the survey party will proceed between two checkpoints over a feature such as a road or railroad, whereas in the course leg technique the survey party will proceed on a straight line course between the two checkpoints. The two checkpoints are marked and labeled on the worksheet overlay and a straight line is drawn between them (para 7-26*b*(1)). All other procedures are the same.

7-28. Contour Line Determination

Dose-rate contour lines depicting the contamination hazard in an area can be drawn when all the dose-rate information in the area is posted. This process is accomplished by—

★*a.* Determining the H + 1 dose-rate contour lines to be plotted (for example, 20, 30, 100, 300, 1,000 rad/hr).

b. Determining the points along the various survey routes, course legs, and near monitoring locations where the desired dose rates are located; interpolate linearly between dose rates, if necessary.

c. Connecting all the points having the same dose rates with a smooth line. Use all plotted monitoring data as additional guides in constructing these contours.

7-29. Contour Line Plotting

a. The CBRE, upon receipt of survey data, plots the location, time of reading, and normalized dose rates on the radiological contamination overlya. Points of equal dose rates are connected to give a series of contour lines by interpolating between the plotted dose rates. The plotter must use care and judgment in plotting these contours and must visualize the probable general shape and direction of the pattern. In addition, he must carefully weigh dose-rate readings indicating possible hot spots. These will appear as dose rates disproportionately higher than other readings in the immediate area. When such readings are reported, a recheck in that area should be made; if confirmed, these hot spots should be plotted and indicated clearly.

b. The plotted contours may be extended or extrapolated to areas downwind in which fallout has not arrived and may be extended to intersect with ground zero if necessary to complete the fallout pattern. As more information is received, the pattern is altered accordingly and thus maintained up to date. Figure 7-6 shows a typical plot which might be developed from survey data.

7-30. Contour Drawing Considerations

★In the construction of the radiological contamination overlay, proper consideration must be given to factors which locally affect the contamination pattern. This is particularly true between points in an aerial survey. These factors include, among others, presence of terrain features such as bluffs or cuts, heavily builtup or wooded areas, and bodies of water. For example, a large river will carry away the fallout which lands in it, leaving its path relatively free of contamination. Similarly, the contamination hazard near a lake will be lower than expected since the fallout particles will sink to the bottom and the water will provide shielding. In wooded areas or built-up areas, a measure of the reduction of dose rate can be obtained by using the transmission factors (see fig. 5-3) for these areas.

Section VI. PRESENTATION AND DISSEMINATION OF RADIOLOGICAL CONTAMINATION INTELLIGENCE

7-31. General

The purpose of preparing a radiological contamination overlay is to provide the commander and staff with a means of estimating or evaluating the effect of the radiological contamination hazard on current or future mission requirements. The format of the radiological contamination overlay is not prescribed but will depend on whether it is to be used for estimation or evaluation purposes. The following paragraphs illustrate some of the possible presentation formats.

7-32. Radiological Contamination Overlays (Evaluation)

Radiological contamination overlays to be used for evaluation purposes must provide the most detailed information.

a. The minimum information required is—

(1) Map designation and orientation data.

(2) Nuclear burst and ground zero identification.

(3) H-hour.

(4) Reference time.

(5) Decay exponent.

(6) Time of preparation and validity.

(7) Source of the contamination—fallout, neutron-induced contamination, or radiological agents.

★(8) Militarily significant contamination perimeters:

★(a) New fallout (H-hour to H+48 hours)—20 rad/hr at H+1 for short-term (24-hour) occupancy (also 10 rad/hr at H+1, if longer occupancy of a contaminated area is expected).

(*b*) Old fallout (> H+48 hours) or radiological agents—1 rad/hr at the time of preparation.

(*c*) Neutron-induced contamination— 2 rad/hr at H+1 hour.

(9) Dose-rate information (contour lines and key dose rates, if possible).

b. Additional information desirable but not essential is:

(1) Time-of-completion lines for fallout.

(2) Reference time dose for key crossings or probable stay times.

7-33. Radiological Contamination Overlays (Estimation)

A radiological contamination overlay prepared for evaluation purposes does not lend itself to briefings and similar requirements. Here, a presentation of the current radiological contamination picture is required which will enable the viewer to visualize the current hazard and the decay of the hazard over a short (3-to 6-hour) period of time in the future. This form of intelligence is of particular use for the commander's briefing and for operations of CBRE's where detailed dose estimations are not required but where a quick visualization of the contamination hazard is essential.

a. An example of a contamination overlay prepared for estimation purposes, showing dose rates is given in figure 7-7.

b. an example of a contamination overlay prepared for estimation purposes, showing dose areas for various times of stay, is given in figure 7-8.

7-34. Dissemination of Overlays

Operations in a nuclear environment will require frequent exchange of radiological intelligence. Radiological contamination overlays may be disseminated by any of the following methods, arranged in order of preference:

a. Electrical Transmission of Hard Copy. Because of its speed and accuracy, the preferred method for transmitting a radiological contamination overlay is by hard copy channels of electrical communications (for example, facsimile). Facsimile devices are normally available at division and higher headquarters. These devices will be used to transmit contamination overlays to lateral and higher commands.

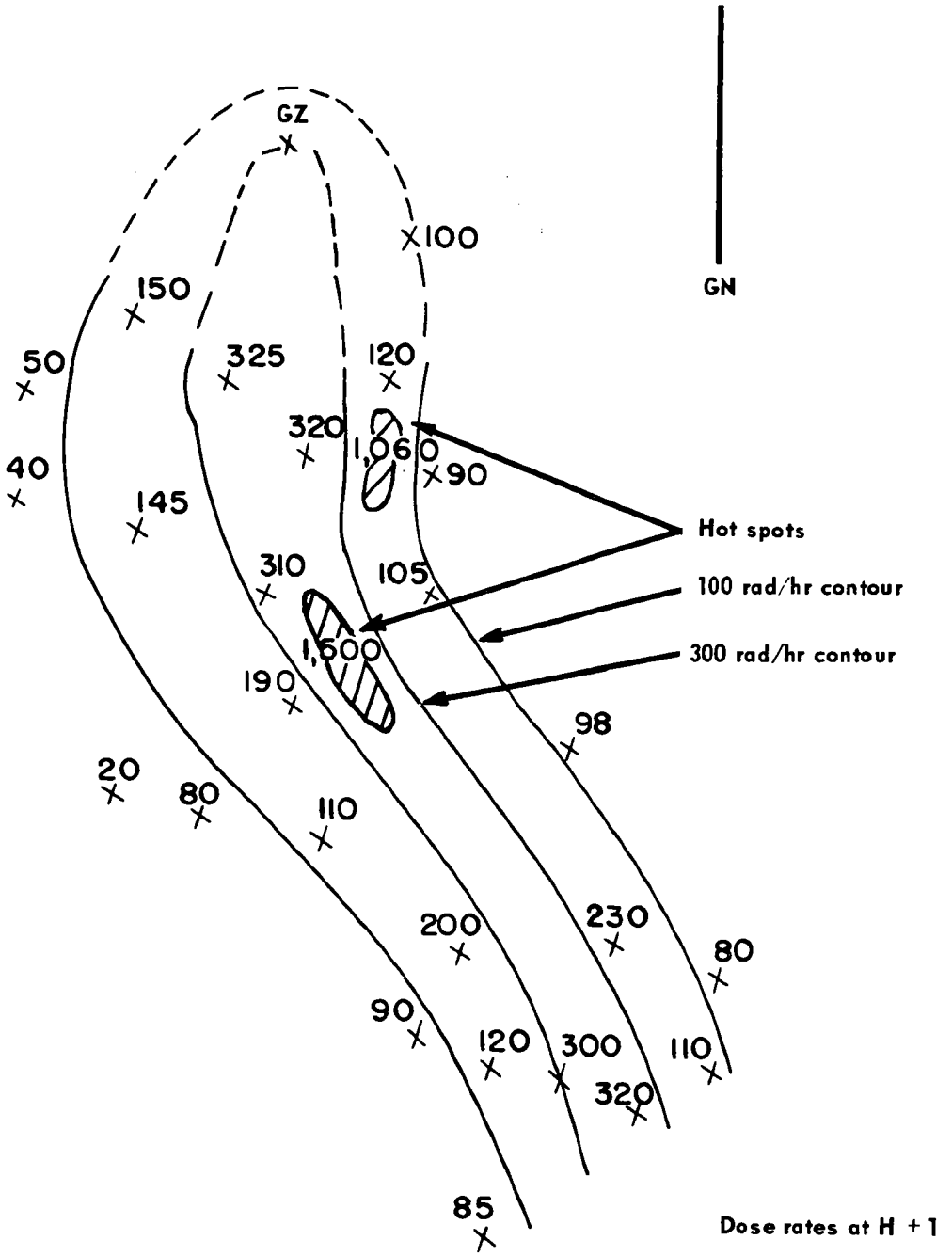


Figure 7–6. Fallout pattern plotted from survey data.

b. NBC 5 Report. When hard copy channels of electrical communications are not available, the radiological contamination chart is transformed into a series of readings and coordinates for transmission with the NBC 5 (Nuclear) report as prescribed in STANAG 2103 (app C). From the division CBRE the readings should be transmitted to the three brigades; the division artillery; the armored cavalry squadron; the aviation, signal, and engineer battalions; the MP company; the support command of the division attached units; and any other

units designated by the commander. A disadvantage of this method is that it requires the addressee to replot data from the NBC 5 report and draw in dose-rate contours, a time consuming process. Staff planners must consider that the shape of dose-rate contours drawn to correspond with a relatively brief series of readings and coordinates can vary significantly. If practical the NBC 5 report should be followed by messenger-delivery of a hard copy (*c* below).

c. Messenger. If electrical communications for hard copy are not available and if time and distance permit, radiological contamination overlays are disseminated by messenger to refine data transmitted by NBC 5 reports.

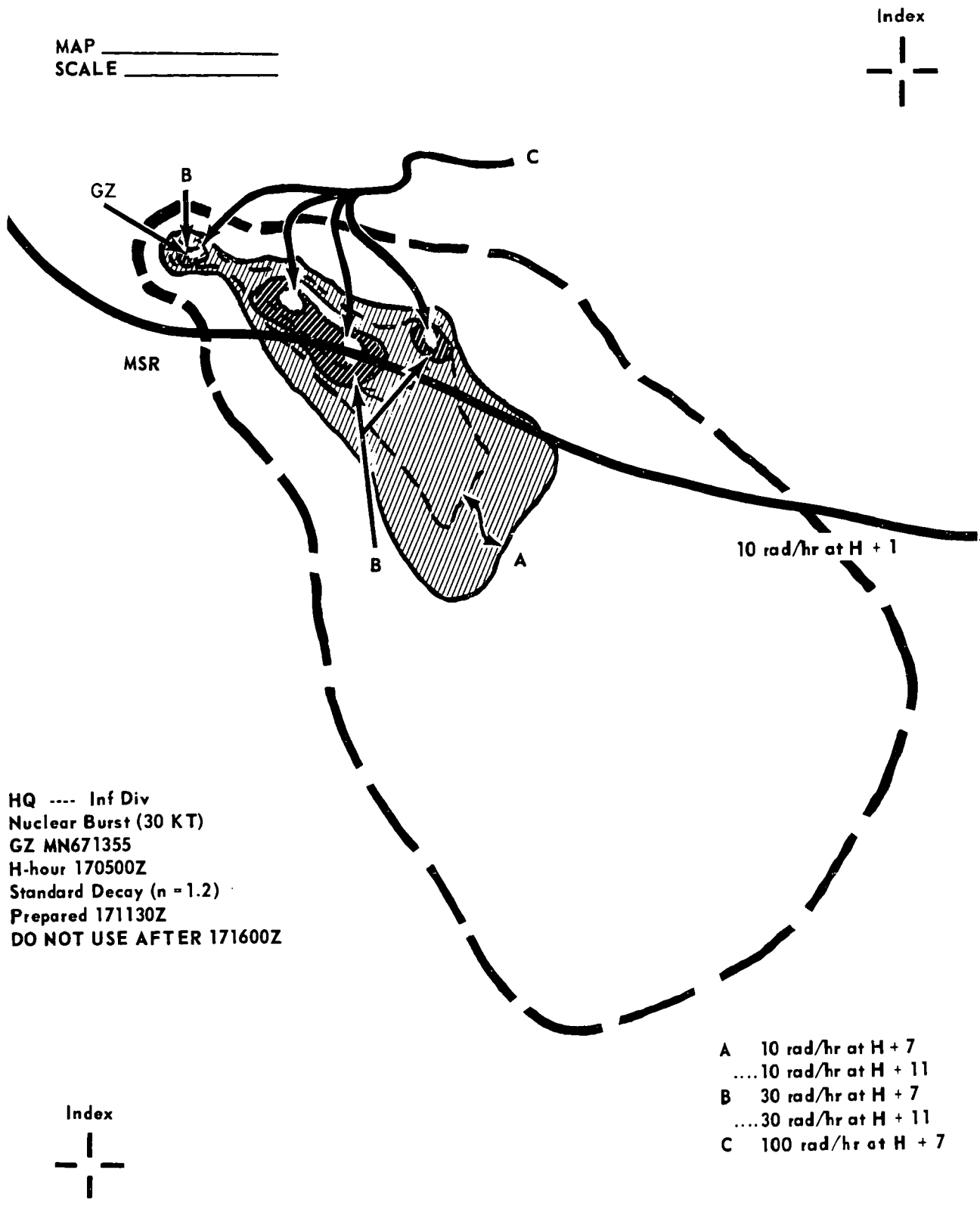


Figure 7-7. Current estimated radiological contamination overlay (dose-rate type).

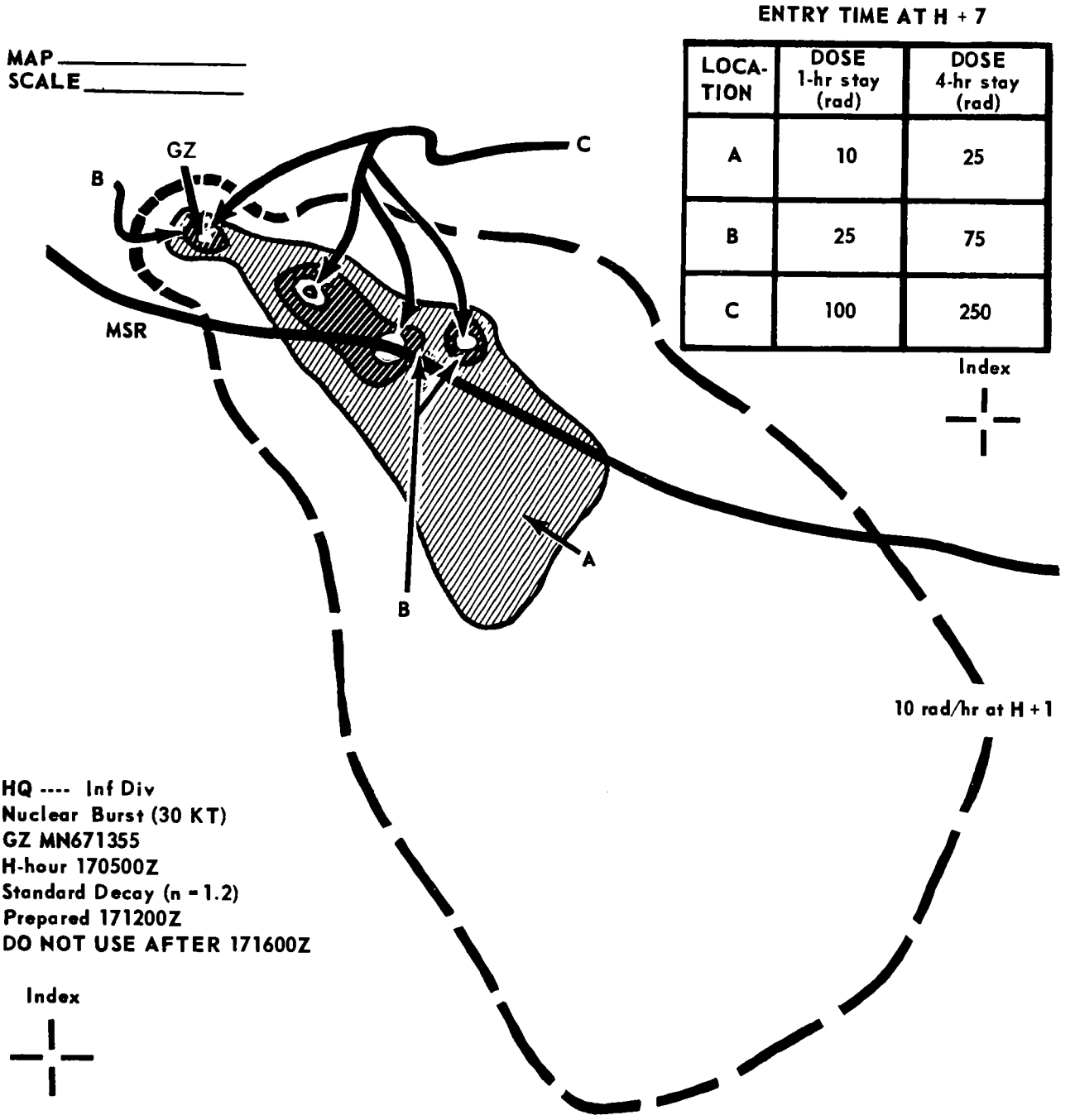


Figure 7–8. Current estimated radiological contamination overlay (dose type).

APPENDIX A

REFERENCES

A-1. Army Regulations (AR)

220-58	Organization and Training for Chemical, Biological, and Radiological (CBR) Operations
310-25	Dictionary of United States Army Terms
310-50	Authorized Abbreviations and Brevity Codes

A-2. Field Manuals (FM)

1-100	Army Aviation Utilization
1-105	Army Aviation Techniques and Procedures
3-1	Chemical, Biological, and Radiological (CBR) Support
6-15	Artillery Meteorology
21-40	Chemical, Biological, Radiological, and Nuclear Defense
21-41	Soldier's Handbook for Defense Against Chemical and Biological Operations and Nuclear Warfare
21-48	Chemical, Biological, and Radiological (CBR), and Nuclear Defense Training Exercises
24-1	Tactical Communications Doctrine
30-5	Combat Intelligence
30-20	Aerial Surveillance—Reconnaissance, Field Army
61-100	The Division
101-5	Staff Officers' Field Manual: Staff Organization and Procedure
101-31-1	Staff Officers' Field Manual: Nuclear Weapons Employment, Doctrine and Procedures

A-3. Technical Manuals (TM)

3-210	Fallout Prediction
3-220	Chemical, Biological, and Radiological (CBR) Decontamination
11-6665-209-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual, Including Repair Parts and Special Tool Lists: Radiac Sets AN/PDR-27J, AN/PDR-27L, and AN/PDR-27Q
11-6665-214-10	Operator's Manual: Radiacmeters IM-9E/PD, IM-93/UD, IM-93A/UD, and IM-147/PD
11-6665-232-12	Operator and Organizational Maintenance Manual, Including Repair Parts and Special Tool Lists: Radiacmeter IM-174A/PD

A-4. Department of the Army Pamphlets (DA Pam)

39-3	The Effects of Nuclear Weapons

310–1	Index of Administrative Publications
310–3	Index of Doctrinal, Training, and Organizational Publications
310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders

A–5. Miscellaneous

JCS Pub 1	Dictionary of United States Military Terms for Joint Usage
(C) DASA EM–1	Capabilities of Nuclear Weapons (U)
ASubjScd 3–18	Radiological Survey and Monitoring
CTA 50–914	Individual Safety and Protective Clothing and Equipment
TB CML 92	Calculator Set, Nuclear, M28
TF 3–4100	Nuclear Burst Reporting
TOE 3–500	Chemical Service Organization
NORADM 55–19, Vol VIII	NORAD NBC Reporting Procedures and Techniques

APPENDIX B

SAMPLE INDEX TO CBR ANNEX OF AN INFANTRY DIVISION SOP

Note. The following example of an appendix, for fallout prediction and radiological monitoring and survey, to the CBR annex of an infantry division SOP is furnished as a guide. Contents of the SOP and annexes vary with the mission, experience, and training of the unit. Separate appendixes to the CBR annex of the SOP may be required for such functions as personnel and equipment monitoring, decontamination, and other areas of radiological defense.

(Classification)

21st Inf Div
FORT McCLELLAN, ALABAMA
14 June 19____

ANNEX M CBR
APPENDIX I (FALLOUT PREDICTION AND RADIOLOGICAL MONITORING AND SURVEY)

1. APPLICATION

Div SOP applies except as modified by division orders. Subordinate unit SOP's will conform. Attached units will comply with this SOP.

2. REFERENCES

★FM 3–1, Chemical, Biological, and Radiological (CBR) Support.
FM 3–12, Operational Aspects of Radiological Defense.
FM 21–40, Chemical, Biological, Radiological, and Nuclear Defense.
★FM 24–1, Tactical Communications Doctrine.
FM 101–5, Staff Officer's Field Manual: Staff Organization and Procedure.
TM 3–210, Fallout Prediction.

3. ORGANIZATION

No change from current organization.

4. DUTIES AND RESPONSIBILITIES

a. Subordinate Headquarters.

(1) *Training.* Subordinate headquarters will insure that specified individuals are trained and are available to fulfill their responsibilities for radiological monitoring, radiological survey, nuclear burst estimation, and

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fallout prediction as described in FM 3–12 or TM 3–210. All aerial observers will be trained as aerial radiological survey monitors. All aviators will be trained to perform aerial survey duties. Assigned ground members crew of aviation units will be trained as aerial radiological survey monitors to provide an emergency capability.

★(2) *Equipment.* Radiological survey parties requested by division for centralized survey requirements will be equipped as specified in FM 3–12. Communications equipment required will be specified when a ground survey party is requested. Companies with available armored vehicles will equip ground radiological survey parties with armored vehicles. Companies providing aerial survey monitors will supply a watch with sweep-second hand. All other equipment for the aerial radiological survey party will be provided by the aviation battalion. Dosimeter IM–93( )/UD will be provided the aerial survey party, whenever possible. The IM–147/PD may be used.

(3) *Procedures.*

(*a*) *General.* Procedures for developing radiological contamination information are established in FM 3–12. Subordinate headquarters will establish monitoring and nuclear burst estimation procedures adequate to provide data for required reports. Monitoring is to be conducted from within shelter whenever possible.

(*b*) *Decentralized radiological survey.* Battalion and larger units will be prepared to plan, control, and conduct ground and aerial radiological surveys as directed. Division will specify aircraft required and means of communication when aerial survey is ordered. Surveys initiated by subordinate headquarters will be coordinated with division headquarters.

b. Staff.

(1) *Staff responsibilities.* These responsibilities are established in FM 101–5 and FM 3–12.

(2) *Dissemination.* Lists will be maintained by the chemical officer for fallout prediction dissemination. Subordinate units and staff officers requiring fallout prediction will coordinate requirements as follows:

(*a*) Prestrike fallout prediction for friendly nuclear attack. Dissemination will be to FSE for incorporation in target analysis and as specified by G3.

(*b*) Poststrike fallout prediction for friendly nuclear attack. Dissemination will be as specified by G3.

(*c*) All fallout predictions for enemy nuclear attacks. Dissemination will be as specified by G2.

(*d*) Effective downwind messages will be disseminated by the CBRE to all subordinate headquarters each time upper air wind data are received. (For format, see TM 3–210.) Subordinate headquarters that are not on the fallout prediction dissemination list but desire fallout predictions will use the effective downwind message and the simplified fallout prediction method.

(Classification)

(Classification)

★(3) *CBRE.* CBRE organization and responsibilities are discussed in FM3-1. The radiological portion of the CBRE operations will be as established in chapter 7, FM 3-12.

(4) *Centralized radiological survey.* Centralized radiological surveys will be planned, controlled, and coordinated by the CBRE in accordance with chapter 4, FM 3-12. Survey parties will be drawn from subordinate units.

5. RADIOLOGICAL CONTAMINATION WARNING

A warning will be broadcast over the division warning net whenever fallout occurs or new contamination is detected within the division area. This warning will be initiated by division (CBRE). Formats of fallout warnings and contamination plottings are shown in tabs A and B.

6. REPORTS

a. Automatic Reports. Units will automatically submit those reports specified in chapter 3, FM 3-12.

b. Special Reports.

(1) *Summary reports.* On direction of this headquarters, major subordinate units will submit a summary report showing the radiation situation in their assigned areas of responsibility. This report will consist of a series of dose-rate readings indicating the location and date-time of the readings.

(2) *Other special reports.* Other special reports will be submitted as directed.

c. Survey Reports.

(1) Centralized radiological survey reports will be submitted in accordance with chapter 4, FM 3-12. Specific communications facilities and procedures required will be established at the survey party briefing.

(2) Data from decentralized surveys will be forwarded direct to the CBRE as obtained by the controlling agency. Survey reports will be screened for adequacy of data but will not be otherwise processed or consolidated by subordinate headquarters.

d. Nuclear Burst Report Data. When a nuclear burst occurs, all artillery battalion headquarters and headquarters batteries will make nuclear burst information observations, using methods established in chapter 2, FM 3-12. Information will be reported by the most rapid means available to this headquarters in the format described in FM 3-12.

7. COMMUNICATIONS

a. Precedence. Contact reports will be reported with IMMEDIATE precedence. All other reports will be of the highest precedence consistent with operational requirements.

b. Channels. The division communication system will be the primary means used by brigade and separate units in reporting to the division. Subordinate commanders will designate the communications means to be used within their commands to report monitoring, survey, and nuclear

(Classification)

(Classification)

burst information. The division operations/intelligence net will be used as an alternate means.

ACKNOWLEDGE.

DISTRIBUTION: Same as SOP
OFFICIAL:

RELLUM
Maj Gen

/s/Winfield
WINFIELD
G3

★TAB A. Sample Fallout Prediction Message.
★ B. Sample Radiological Contamination Warning.

★TAB A (Sample Fallout Prediction Message) to Appendix I to Annex M, 21st Division SOP

IMMEDIATE 240730 LOCAL
UNCLASSIFIED
REDDOG REDDOG—THIS IS VICTOR VICTOR BREAK
NBC 3 NUCLEAR—NBC 3 NUCLEAR
ALFA 24
DELTA 240700 LOCAL
FOXTROT HILL 301
YANKEE 02520292 DEGREES
ZULU 01201804

AUTHENTICATION OF _____ IS _____

I SAY AGAIN

IMMEDIATE 240730 LOCAL
UNCLASSIFIED
REDDOG REDDOG—THIS IS VICTOR VICTOR BREAK
NBC 3 NUCLEAR—NBC 3 NUCLEAR
ALFA 24
DELTA 240700 LOCAL
FOXTROT HILL 301
YANKEE 02520292 DEGREES
ZULU 01201804

AUTHENTICATION OF _____ IS _____

OUT

(Classification)

(Classification)

★TAB B (Sample Radiological Contamination Warning) to Appendix I to Annex M, 21st Division SOP

IMMEDIATE 241700 LOCAL
UNCLASSIFIED
REDDOG REDDOG—THIS IS VICTOR VICTOR BREAK
NBC 5 NUCLEAR—NBC 5 NUCLEAR
ALFA 24
TANGO 241505 LOCAL

VICTOR ND651455 ND810510
ND821459 ND651455

WHISKEY ND604718 ND991686
ND114420 ND595007

AUTHENTICATION OF _____ IS _____

I SAY AGAIN

IMMEDIATE 241700 LOCAL
UNCLASSIFIED
REDDOG REDDOG—THIS IS VICTOR VICTOR BREAK
NBC 5 NUCLEAR—NBC 5 NUCLEAR
ALFA 24
TANGO 241505 LOCAL

VICTOR ND651455 ND810510
ND821459 ND651455

WHISKEY ND604718 ND991686
ND114420 ND595007

AUTHENTICATION OF _____ IS _____

OUT

(Classification)

APPENDIX C

REPORTING NUCLEAR DETONATIONS AND RADIOACTIVE FALLOUT (NATO STANAG 2103)

C-1. Standardized Report Formats

The standardized formats for reporting enemy nuclear attacks are:

a. NBC 1. Report used by observing unit, giving initial and subsequent data.

b. NBC 2. Report used for passing evaluated data.

c. NBC 3. Report used for immediate warning of expected contamination.

d. NBC 4. Report used for radiation dose-rate measurements.

e. NBC 5. Report used for locating areas of contamination.

C-2. Letter Items

The letter items used in all reports have the following meanings:

★A. Strike serial number(s) if known. (The strike serial number will be assigned by the CBRE at the operations center responsible for the area in which the strike occurs.)

B. Position of observer (UTM or place).

C. Direction measured clockwise from grid or magnetic north (state which) of the attack from observer (degrees or mils, state which).

★D. Date/time of detonation (local or ZULU, state which). (NATO armed forces use ZULU time *only*. If local time is used, transmit the letter of the local time zone, if known; transmit the word "local" if the time zone is unknown. See FM 101-10-1 for time-zone charts.)

E. Illumination time. (Report only when other data are not available, for example, under conditions of poor visibility when cloud measurements cannot be made. Report in seconds.)

F. Location of attack (UTM or place) (actual or estimated, state which).

G. Means of delivery, if known.

H. Type of burst—air, surface, or unknown (state which)—including height, if known.

I. (Not used for nuclear report.)

J. Flash-to-bang time (seconds).

K. Crater present or absent and diameter, if known (meters).

L. Nuclear burst angular cloud width measured at 5 minutes after the detonation (degrees or mils, state which). (Do not report if data are obtained more than 5 minutes after the detonation.)

M. Stabilized cloud-top angle and/or cloud-bottom angle (state which) or cloud-top height and/or cloud-bottom height (state which) measured at H + 10 minutes (mils, degrees, meters, or feet—state which).

N. Estimated yield (KT).

O. Reference data/time for estimated contours when not H + 1 hour.

P. For radar purposes only:

P.A. UTM coordinates of points to outline external contours of radioactive cloud.

P.B. Effective downwind direction (direction from which the wind is blowing) in degrees magnetic or mils (state which).

Q. Location of reading.

R. Dose rate (rad/hr). The words "initial," "increasing," "peak," or "decreasing" may be added. When decay rate is reported, the words "decay normal," "decay fast," or "decay slow," or the actual value of decay exponent may be inserted.

S. Data/time of reading (local or ZULU, state which).

T. H + 1 data/time (local or ZULU, state which).

U. 1,000 rad/hr contour line coordinates (UTM) (red).

V. 300 rad/hr contour line coordinates (UTM) (green).

W. 100 rad/hr contour line cooordinates (UTM) (blue).

★X. 20 rad/hr contour line coordinates (UTM) (black). (See *Note* in paragraph C–7.)

Y. Direction measured clockwise from grid north to the left and then to the right radial lines (degrees or mils, state which—4 digits each).

Z. Effective wind speed (kmph), 3 digits; downwind distance of zone I (km), 3 digits; cloud radius (km), 2 digits. (When effective wind speed is less than 8 kmph, the NBC 3 report will contain only three significant digits, that is, the radial distances of zone I.)

C–3. Format: NBC 1

a. The items "type of report," D, H, and either items B and C or item F (ACTUAL) must always be reported; other items are optional.

b. Users of NBC 1 are not confined solely to the use of letter items shown in the examples; other letter items from paragraph C–2 above may be added at the users' discretion.

Letter	*Meaning*	*Example*
	Precedence*	
	Date/Time (local or ZULU, state which)	
	Security Classification	
	From	
	To	
	Type of Report	NBC 1 (Nuclear)
★A.	Strike serial number, if known	
B.	Position of observer (UTM or place)	B. LB 196400
C.	Direction measured clockwise from grid or magnetic north (state which) of the attack from observer (degrees or mils, state which)	C. Grid 060 degrees
D.	Date/time of detonation (local or ZULU, state which)	D. 201405 (local)
E.	Illumination time (seconds)	
F.	Location of attack (UTM or place) (actual or estimated, state which)	
G.	Means of delivery, if known	
H.	Type of burst—air, surface, or unknown (state which)—including height, if known	H. Surface
J.	Flash-to-bang time (seconds)	J. 60
K.	Crater present or absent and diameter, if known (meters)	
L.	Nuclear burst angular cloud width measured at 5 minutes after the detonation (degrees or mils, state which). (Do not report if data are obtained more than 5 minutes after the detonation.)	L. 280 mils
M.	Stabilized cloud-top angle and/or cloud-bottom angle (state which) or cloud-top height and/or cloud-bottom height (state which) measured at H + 10 minutes (mils, degrees, meters, or feet—state which)	

C–4. Format: NBC 2

a. This report is normally based on two or more NBC 1 nuclear reports. It includes an attack location and an evaluated yield.

b. When adjacent agencies (for example, Navy and Civil Defense organizations) use a different fallout prediction system, this form may be sent to provide basic data for their fallout computations.

* As appropriate or as per unit SOP.

c. Letter items A, D, F, H and N may be repeated as often as necessary to produce a summary report.

d. Users of NBC 2 are not confined solely to the use of the letter items shown in the example; other letter items from paragraph C–2 above may be added at the users' discretion.

Letter	*Meaning*	*Example*
	Precedence	
	Date/Time (local or ZULU, state which)	
	Security Classification	
	From	
	To	
	Type of Report	NBC 2 (Nuclear)
A.	Strike serial number	A. 24
D.	Date/time of detonation (local or ZULU, state which)	D. 201405 (local)
F.	Location of attack (UTM or place) (actual or estimated, state which)	F. LB 187486 actual
G.	Means of delivery, if known	
H.	Type of burst—air, surface, or unknown (state which)—including height, if known	H. Surface
N.	Estimated yield (KT)	N. 50

C–5. Format: NBC 3

a. When adjacent agencies (for example, Navy and Civil Defense organizations) use a different fallout prediction system, NBC 2 may be sent to provide basic data for their fallout computations.

b. Users of NBC 3 are not confined solely to the use of the letter items shown in the example; other letter items from paragraph C–2 above may be added at the users' discretion.

c. When effective wind speed is less than 8 kmph, the NBC 3 report will consist of the letter items D, F, and Z. Z will contain three digits only, that is, the radial distance of Zone I.

Letter	*Meaning*	*Example*
	Precedence	
	Date/Time (local or ZULU, state which)	(a telephone or radio message)
	Security Classification	
	From	
	To	
	Type of Report	NBC 3 (Nuclear)
★A.	Strike serial number	A. 24
D.	Date/time of detonation (local or ZULU, state which)	D. 201405 Z
F.	Location of attack (UTM or place) (actual or estimated, state which)	F. LB 187486 actual
Y.	Direction measured clockwise from grid north to the left and then to the right radial lines (degrees or mils, state which—4 digits each)	Y. 0272–0312 degrees
Z.	Effective wind speed (kmph), 3 digits; downwind distance of zone I (km), 3 digits; cloud radius (km), 2 digits.	Z. 019–025–05

C–6. Format: NBC 4

a. Letter items Q, R, and S may be repeated as often as necessary.

b. Radiation dose rates are measured in the open, 1 meter above ground; other conditions will be specified in the message.

c. Users of NBC 4 are not confined solely to the use of the letter items shown in the examples; other letter items from paragraph C–2 above may be added at the users' discretion.

Letter	*Meaning*	*Example*
	Precedence	
	Date/Time (local or ZULU, state which)	
	Security Classification	
	From	
	To	
	★Type of Report	NBC 4 (Nuclear)
Q.	Location of reading	Q. LB 123987
R.	Dose rate (rad/hr). The words "initial," "increasing," "peak," or "decreasing" may be added. When decay rate is reported, the words "decay normal," "decay fast," "decay slow," or the actual value of decay exponent may be inserted	R. 35
S.	Date/time of reading (local or ZULU, state which) (This is *NOT* normalized to H + 1 hour)	S. 201735 Z
		Q. LB 129965 R. 60 S. 201650 Z Q. LB 146808 R. 27 increasing S. 201710 Z

C-7. Format: NBC 5

★*Note.* The dose rate for letter item X of the NBC 5 nuclear report varies from that in STANAG 2103. The U.S. Army has determined that 20 rad/hr is a more meaningful figure than 30 rad/hr for the militarily significant perimeter of the fallout area at H + 1 hour (para 7-8*c*(1)).

★*a.* The form is best sent as a trace or overlay if time and distance permit.

b. When the contamination arises from a single enemy or unidentified burst, the dose rate always refers to H + 1 hour, and the letter item T is used. When there have been several detonations at different times or on different days and no single H + 1 hour is possible, the dose rates are reported as at a specified time, using letter item O. Letter items O and T are, therefore, alternative and cannot both be used in the same report.

c. It is not necessary or even desirable to report all four of the contours of different dose rates. Four are given to provide flexibility. (In the example only two are reported.)

d. When a contour closes to form a complete ring, the first coordinate is repeated at the end (see example for 300 rad/hr).

★*e.* Colors used for plotting, and when sending the report as a trace, are as follows:

(1) Red for 1,000 rad/hr.

(2) Green for 300 rad/hr.

(3) Blue for 100 rad/hr.

★(4) Black for 20 rad/hr. (See *Note* above.)

f. Contour lines are to be annotated with the dose rates.

★*g.* When requested, decay rates are to be transmitted according to letter item R.

h. Users of NBC 5 are not confined solely to the use of the letter items shown in the example; other letter items from paragraph C-2 above may be added at the users' discretion.

Letter	*Meaning*	*Example*
	Precedence	
	Date/Time (local or ZULU, state which)	
	Security Classification	
	From	
	To	
	Type of Report	NBC 5 (Nuclear)
★A.	Strike serial number	A. 24
O.	Reference date/time for estimated contours (see *b* above) when not H + 1 hour	
T.	H + 1 date/time (local or ZULU, state which)	T. 201505 Z
U.	1,000 rad/hr contour line coordinates	
V.	300 rad/hr contour line coordinates	V. ND 651455 ND 810510 ND 821459 ND 651455
W.	100 rad/hr contour line coordinates	W. ND 604718 ND 991686 ND 114420 ND 595007
★X.	20 rad/hr contour line coordinates (See *Note* above.)	

C-8. Format for Effective Downwind Message

★*a.* The format for the effective downwind message, transmitted with the effective downwind direction and wind speed for six preselected yield groups, is as follows:

Effective Downwind Message	
ZULU	D D t t t t
ALFA	d d d s s s
BRAVO	d d d s s s
CHARLIE	d d d s s s
DELTA	d d d s s s
ECHO	d d d s s s
FOXTROT	d d d s s s

★*b.* ZULU D D t t t t is the date and time at which the winds were measured (for example, 250600 is the 25th day of the month at 0600 hours).

c. ALFA, BRAVO, CHARLIE, DELTA, ECHO, and FOXTROT are the yield groups:

★(1) ALFA is 2 KT or less.

(2) BRAVO is more than 2 KT to 5 KT.

(3) CHARLIE is more than 5 KT to 30 KT.

(4) DELTA is more than 30 KT to 100 KT.

(5) ECHO is more than 100 KT to 300 KT.

(6) FOXTROT is more thas 300 KT to 1 MT.

★*d.* Effective downwind direction is d d d and wind speed in kilometers per hour is s s s.

For example, ALFA 080025 is an effective downwind direction of 080 degrees and an effective wind speed of 025 kilometers per hour for yields of 2 KT or less.

Note. TM 3-210 contains information on the use of the effective downwind message.

APPENDIX D
RECOMMENDED ARMY UNITS FOR NUCLEAR BURST DATA COLLECTION AND REPORTING*

D-1. Introduction
This appendix presents lists of units, primary and alternate, considered to be the most suitable (from the standpoints of battlefield location and angle-measuring equipment) for nuclear burst data collection. Suitable units for aerial observation are also presented. Schematic illustrations of envisioned nuclear burst data flow are also presented.

D-2. Division
a. Primary Collection Units (fig. D-1).

(1) H & H Battery, Field Artillery Battalion, 105mm (TOE 6-156, 6-216, 6-706).

(2) H & H Battery, Field Artillery Battalion, 155mm (TOE 6-366).

(3) H & H Battery, Field Artillery Battalion, 155mm/8-inch (TOE 6-166, 6-356).

(4) H & H Battery, Field Artillery Battalion, HONEST JOHN (TOE 6-176).

(5) H & H Battery, Field Artillery Battalion, LANCE (TOE 6-196) (when activated).

b. Alternate Collection Units (fig. D-2).

(1) Armored Cavalry Troop (TOE 17-77, 17-99, 17-107).

(2) H & H Company, Maneuver Battalion (TOE 7-16, 7-36, 7-46, 7-58, 17-16, 17-36).

(3) Rifle Company (TOE 7-18, 7-37, 7-47, 7-57).

(4) Tank Company (TOE 17-37).

c. Aerial Collection Units (figs. D-3 and D-4).

(1) Aviation GS Company, Airborne Division (TOE 1-58).

(2) Aviation GS Company, Infantry Division (TOE 1-78).

(3) Aviation GS Company, Airmobile Division (TOE 1-102).

D-3. Corps
a. Primary Collection Units (figs. D-5 and D-6).

(1) H & H Battery, Field Artillery Battalion, 175mm (TOE 6-436).

(2) H & H Battery, Field Artillery Battalion, HONEST JOHN (TOE 6-526).

(3) H & H Battery, Field Artillery Battalion, LANCE.

(4) H & H Battery, Field Artillery Battalion, SERGEANT (TOE 6-556).

(5) H & H Battery, Field Artillery Target Acquisition Battalion (TOE 6-576).

(6) H & H Battery, Air Defense Artillery Battalion, HAWK (TOE 44-236, 44-( )).

(7) Air Defense Artillery Battery, HAWK (TOE 44-237, 44-( )).

(8) H & H Battery, Air Defense Artillery Battalion, NIKE HERCULES (TOE 44-536).

(9) Air Defense Artillery Battery, NIKE HERCULES (TOE 44-537).

b. Alternate Collection Units.

(1) Searchlight Battery (TOE 6-558).

(2) H & H Battery, Field Artillery Battalion, 8-inch SP (TOE 6-416).

(3) H & H Battery, Field Artillery Battalion, 155mm SP (TOE 6-366).

(4) Armored Cavalry Troop (TOE 17-127).

c. Aerial Collection Units (fig. D-7).

(1) Aerial Surveillance Company (TOE 1-128).

(2) Aviation Company (TOE 1-127).

*This appendix is included for information only. It may be used as a reference and as an aid to commanders in reviewing their nuclear burst collection effort.

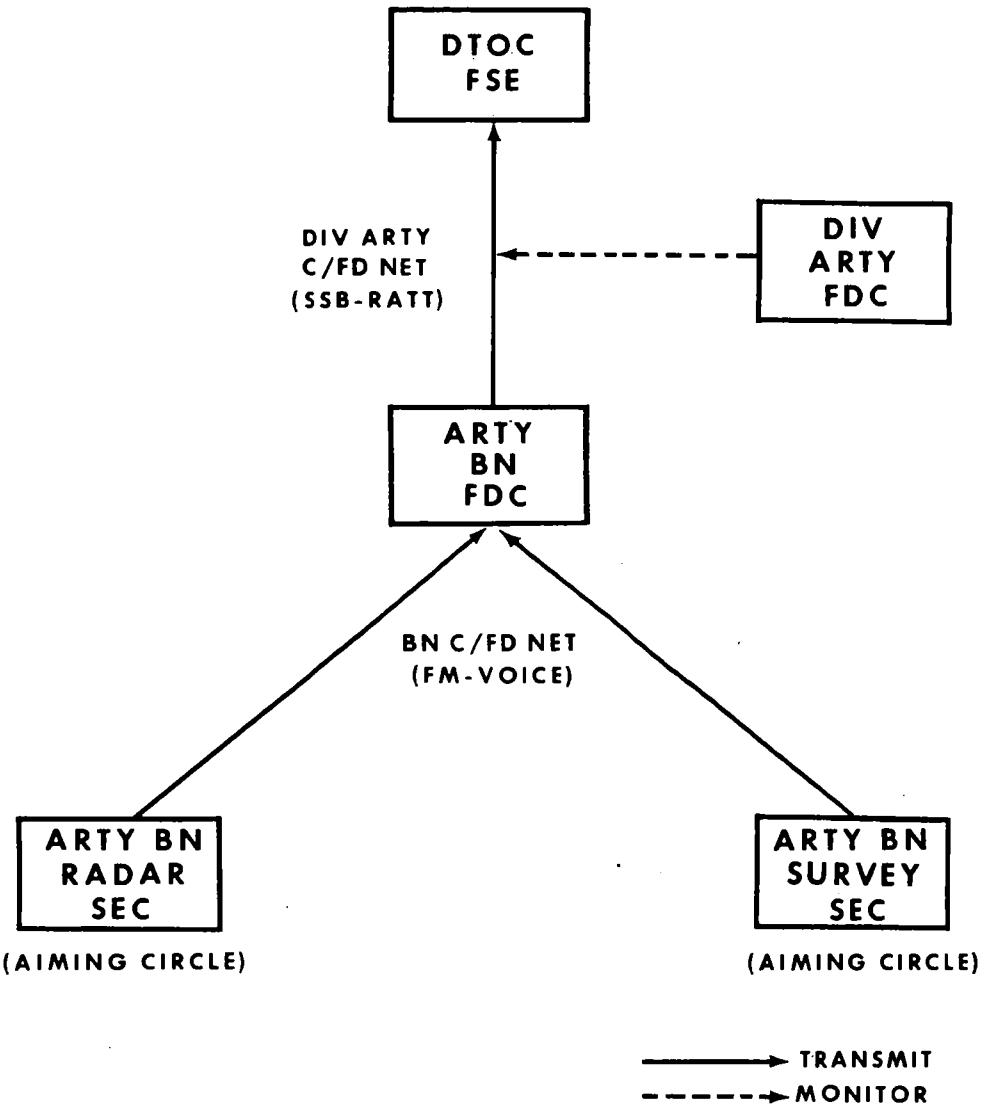


Figure D–1. Schematic flow of nuclear burst data in the division: Primary collection units (ground observation).

D–4. Field Army, Including Field Army Support Command (FASCOM)

a. Primary Collection Units (fig. D–8).

(1) Field Artillery Battery, PERSHING (TOE 6–617).

(2) H & H Battery, Air Defense Artillery Battalion, HAWK (TOE 44–236, 44–( )).

(3) Air Defense Artillery Battery, HAWK (TOE 44–237, 44–( )).

(4) H & H Battery, Air Defense Artillery Battalion, NIKE HERCULES (TOE 44–536).

(5) Air Defense Artillery Battery, NIKE HERCULES (TOE 44–537).

b. Alternate Collection Units.

(1) Armored Cavalry Regiment (TOE 17–51).

(2) Separate Armored Brigade (TOE 17–100).

(3) Separate Mechanized Brigade (TOE 37–100).

c. Aerial Collection Unit (fig. D–9). Army Aviation Company (TOE 1–137).

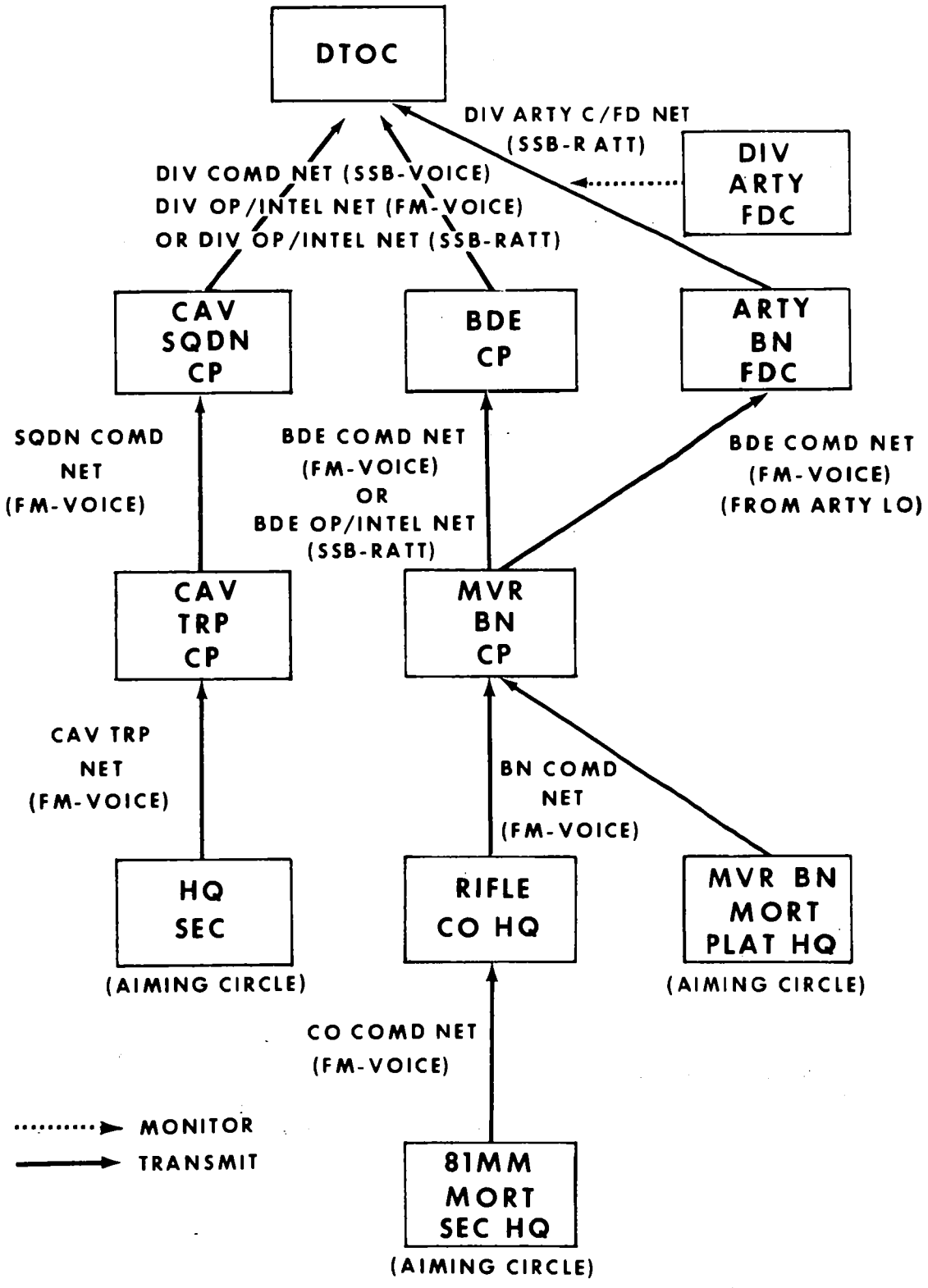


Figure D-2. Schematic flow of nuclear burst data in the division: Alternate collection units (ground observation).

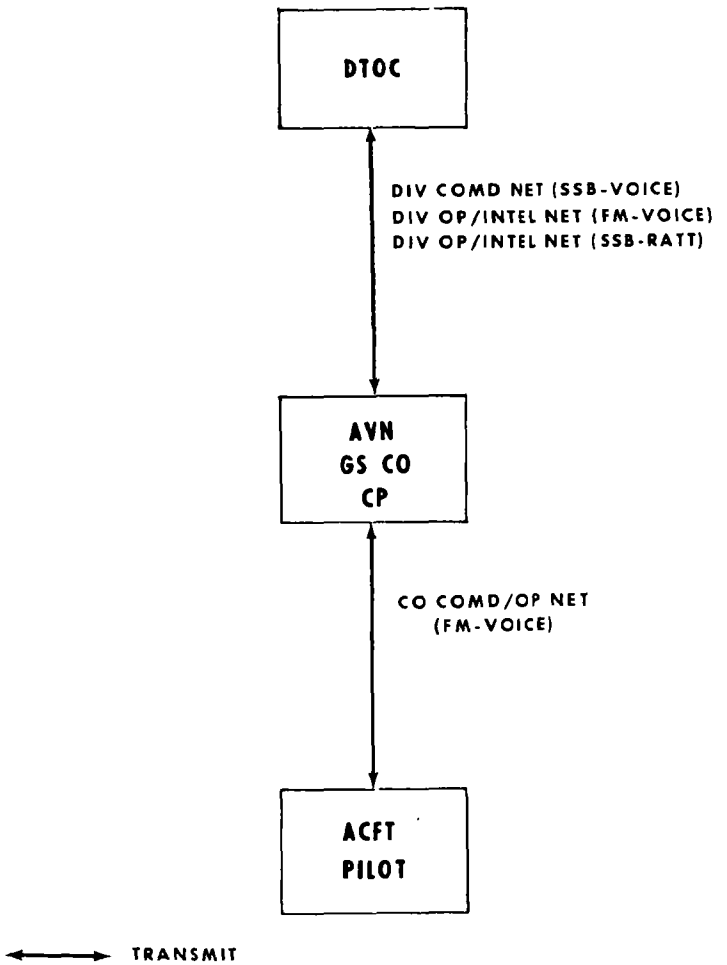


Figure D–3. Typical schematic flow of requests for and reports of nuclear burst parameter measurements: Airborne and infantry divisions (aerial observation).

D–5. The Communications Zone (COMMZ)/ Theater Army Support Command (TASCOM)

a. Primary Collection Units (fig. D–10).

(1) H & H Battery, Air Defense Artillery Battalion, HAWK (TOE 44–236).

(2) Air Defense Artillery Battery, HAWK (TOE 44–237).

(3) H & H Battery, Air Defense Artillery Battalion, NIKE HERCULES (TOE 44–536).

(4) Air Defense Artillery Battery, NIKE HERCULES (TOE 44–537).

b. Alternate Collection Units. Units may be designated as collection units on an "as required" basis. The specific units designated are dependent on the type and location of tenant units in the area support command.

c. Aerial Collection Units.

(1) Aviation Service Support Company.

(2) Tenant Air Force Units.

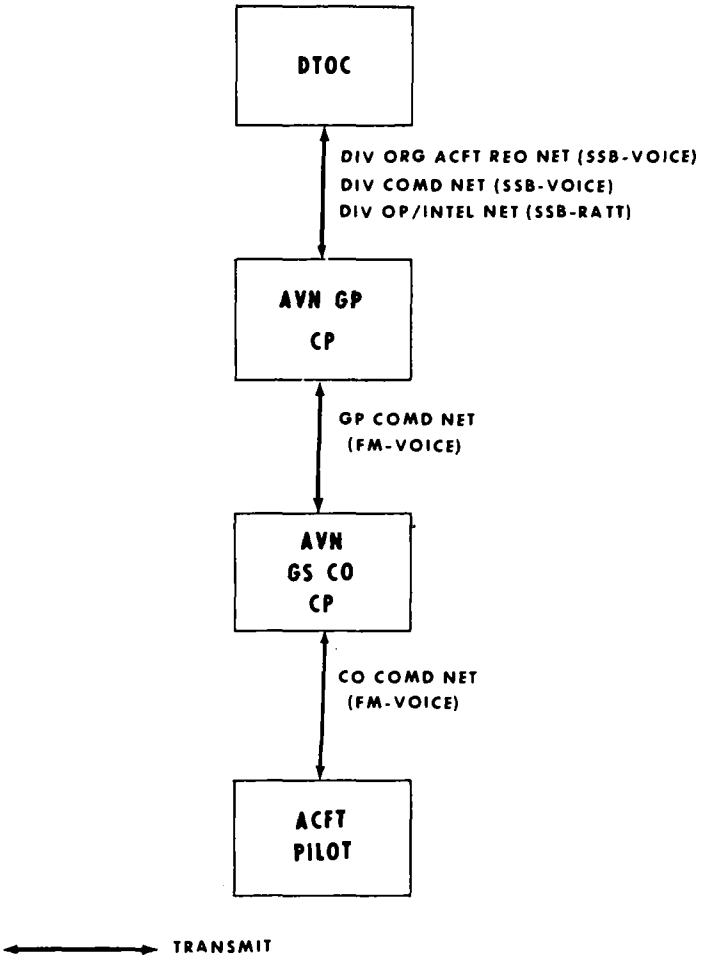


Figure D–4. Typical schematic flow of requests for and reports of nuclear burst parameter measurements: Airmobile division (aerial observation).

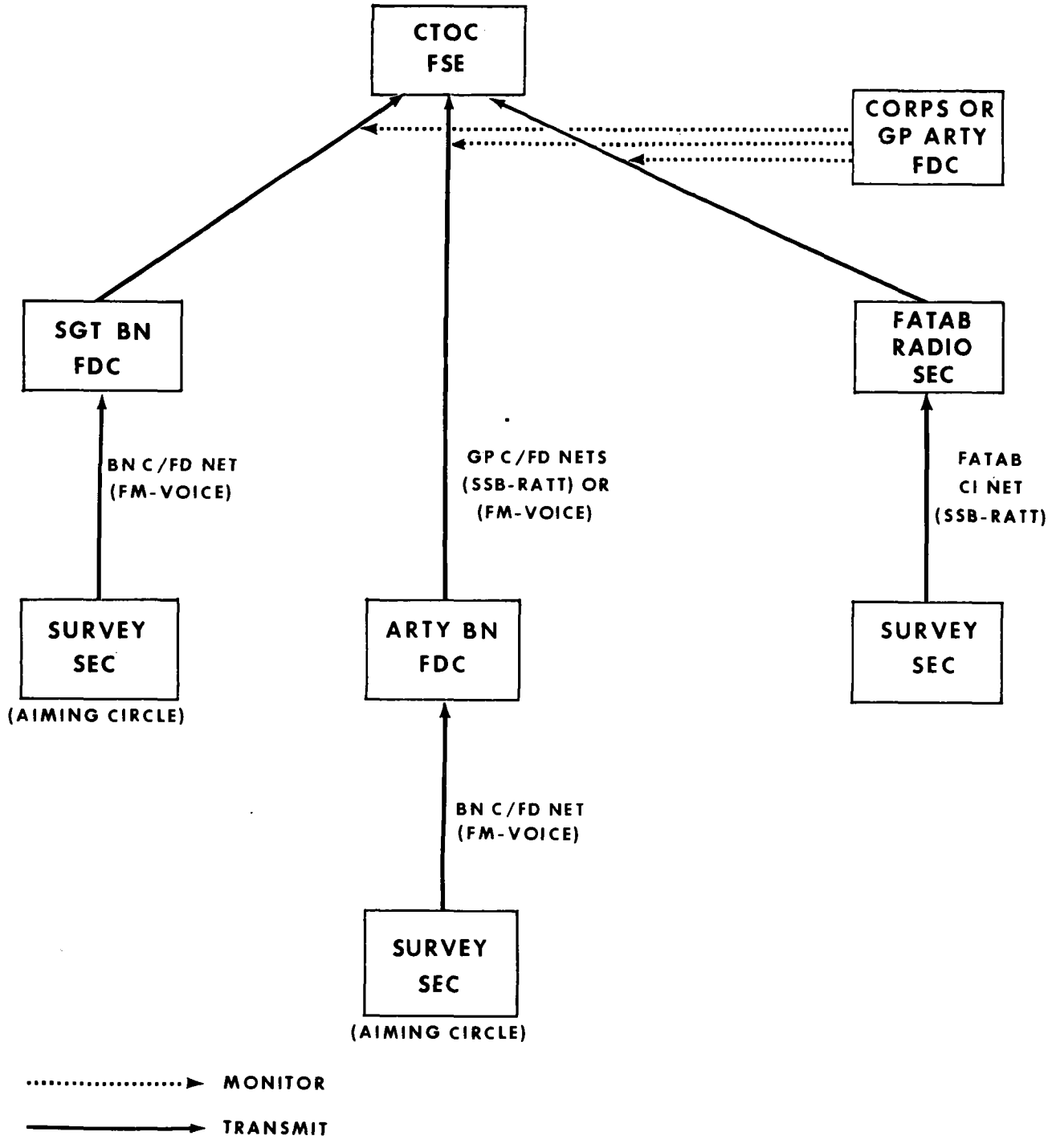


Figure D–5. Schematic flow of nuclear burst data in the corps: Field artillery collection units (ground observation).

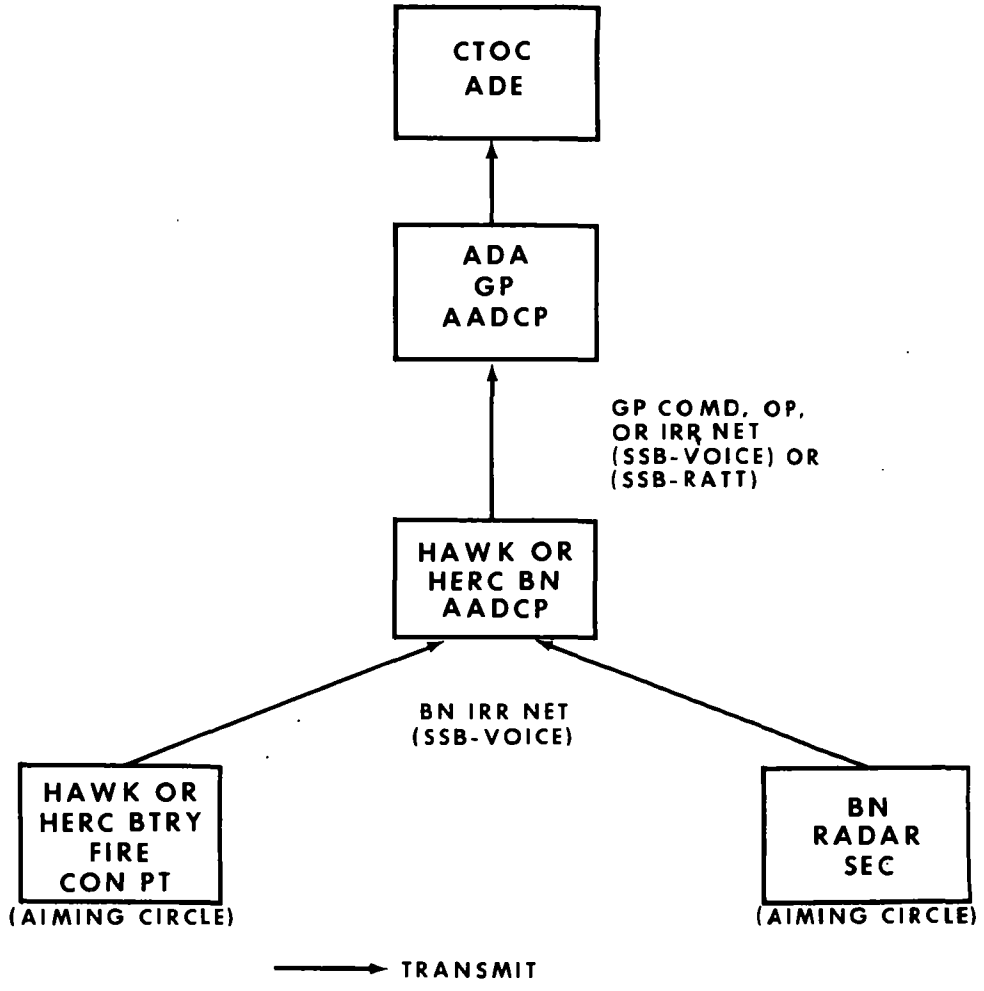


Figure D–6. Schematic flow of nuclear burst data in the corps: Air defense artillery collection units (ground observation).

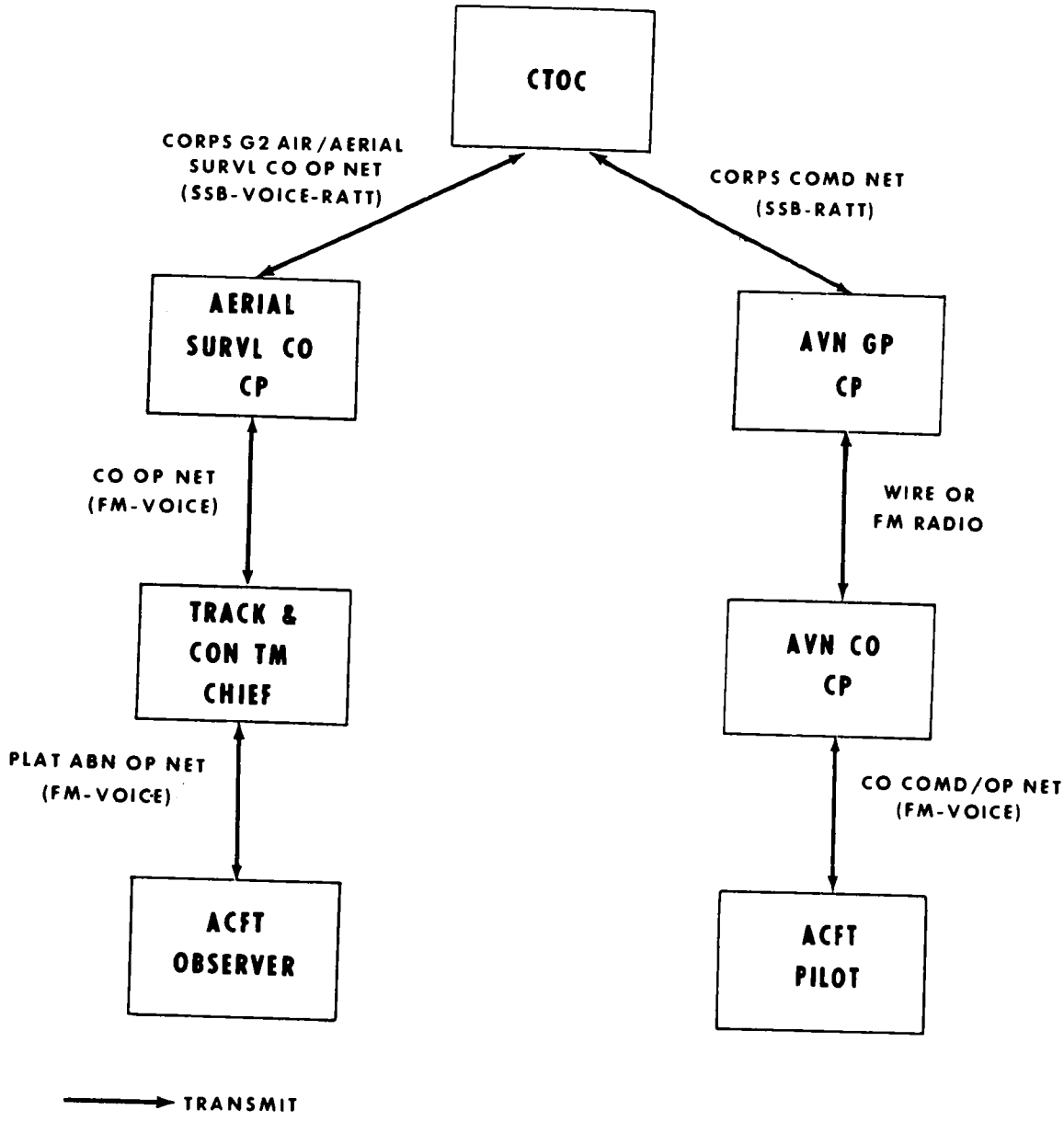


Figure D–7. Typical schematic flow of requests for and reports of nuclear burst parameter measurements: Corps (aerial observation).

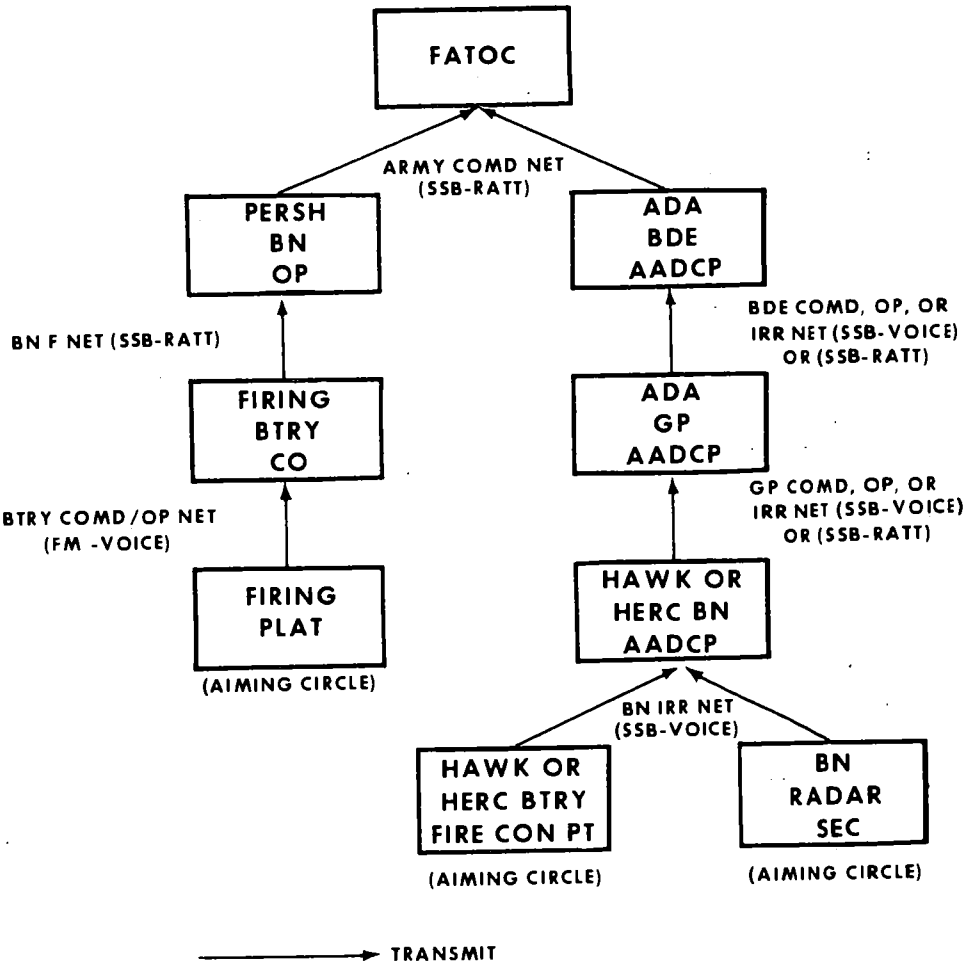


Figure D–8. Schematic flow of nuclear burst data in the field army (ground observation).

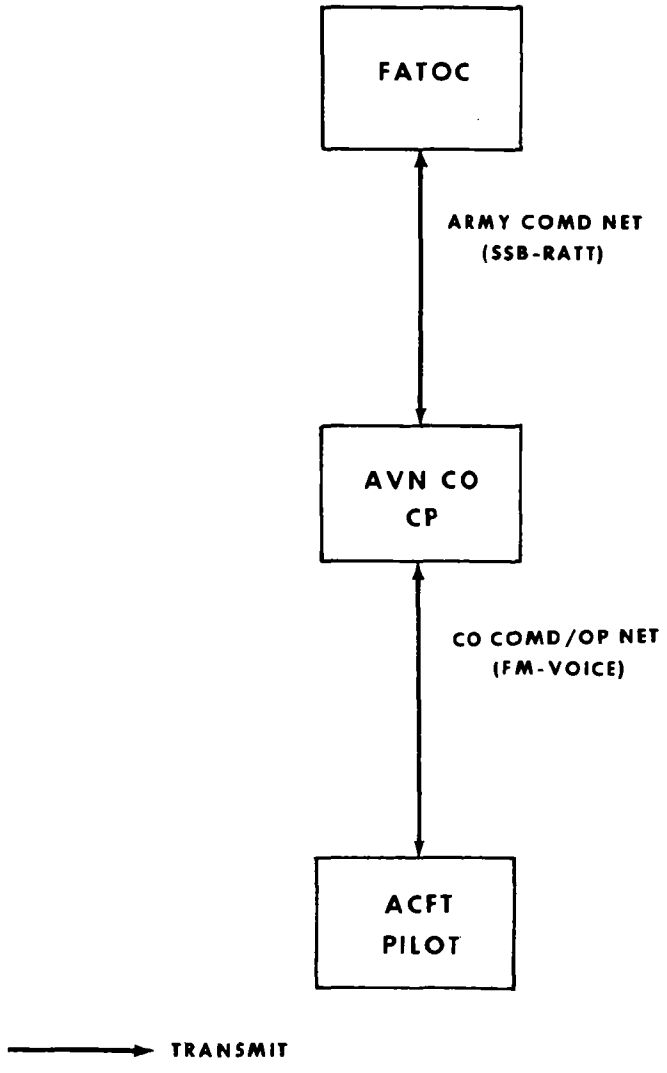
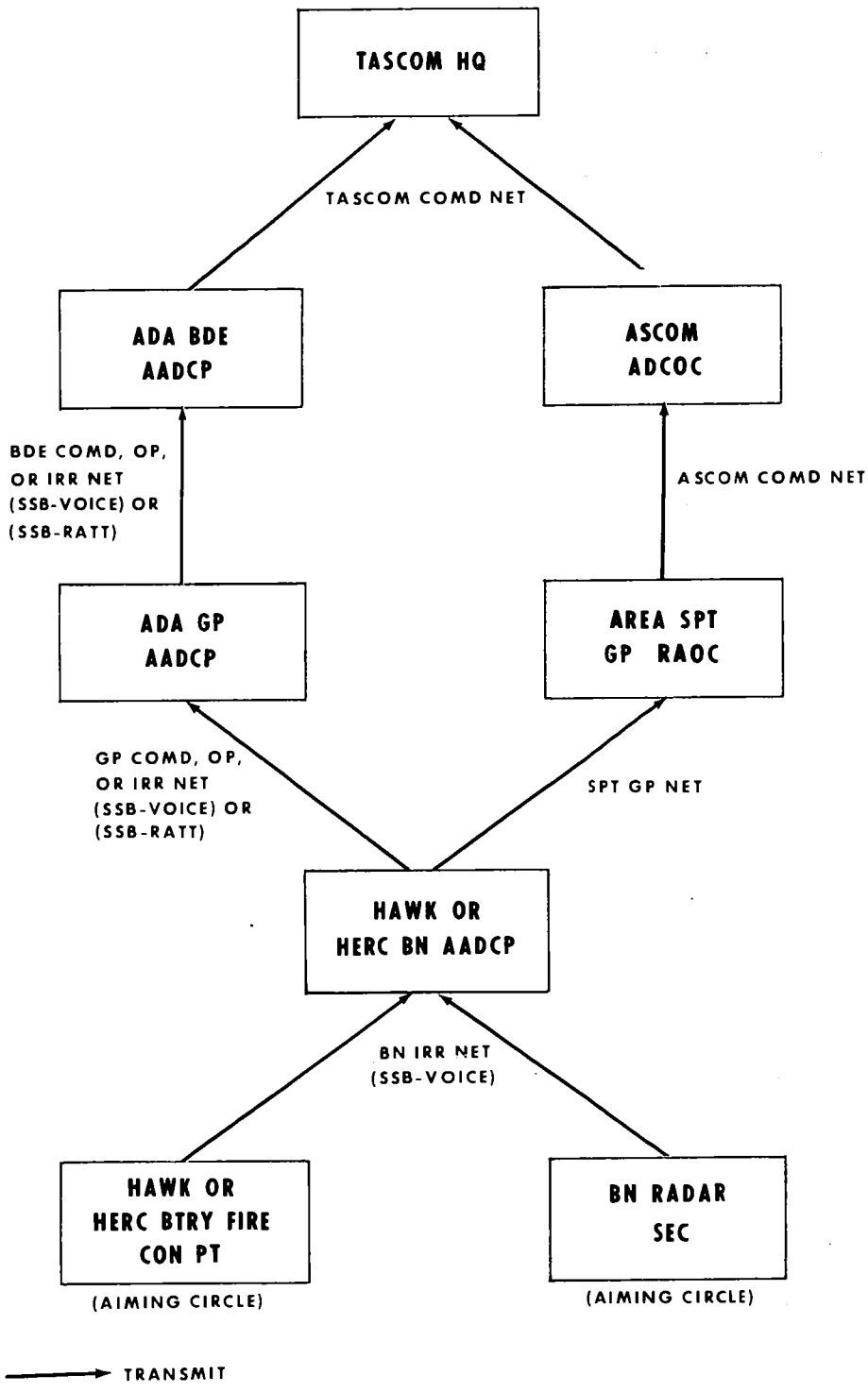


Figure D-9. Typical schematic flow of requests for and reports of nuclear burst parameter measurements: Field army (aerial observation).



★*Figure D–10. Schematic flow of nuclear burst data in the communications zone (ground observation).*

APPENDIX E
DESCRIPTION OF NUCLEAR DETONATION DATA REPORTING SYSTEM FOR USMC USERS

Section I. GENERAL

E-1. Introduction

This appendix establishes an interim system for the reporting of nuclear detonation data by the U.S. Marine Corps. It is designed to provide timely information to appropriate commanders on enemy, friendly, and unidentified nuclear detonations (NUDET) and to provide NUDET warnings to higher and lateral headquarters, and subordinate units. The manual of which this appendix is a part is a Joint U.S. Army—Fleet Marine Force Manual (FM 3-12/FMFM 11-5); however, this appendix is applicable solely to USMC units. This system reflects Marine Corps terminology, equipment, and tactical doctrine and only supersedes the basic manual for reporting nuclear detonations. The principles, methods, and techniques for reporting fallout and radiological contamination are applicable to the U.S. Marine Corps. The interim system described in this appendix does not extend higher than Division/Wing. Above Division/Wing level the extension of this system, as required, will be accomplished using the most appropriate communications provided for similar purposes.

E-2. Nuclear Detonation Parameters

a. General. Nuclear detonation (NUDET) parameters are those features associated with a detonation that are capable of being measured, observed, or calculated so as to provide data needed for determining the yield, type of detonation (fallout or nonfallout producing), location of ground zero, and time of detonation.

b. Use. Information relative to nuclear detonations is needed by commanders and staffs for estimates of the situation and for fallout predictions. Specifically, the NUDET information may be used to establish or identify the type of detonation, the damage resulting from the attack, and the status of friendly forces, all of which are part of the estimate of the situation. The essential NUDET data necessary to fulfill these requirements are—

(1) Date and time of the nuclear detonation (NUDET).

(2) Location of ground zero.

(3) Estimate of the yield.

(4) Type of detonation.

These and other parameters of the detonation and observer location are described in paragraph 2-8 of this manual.

E-3. Description of the Interim System

a. Organization. The reporting system is a command-wide manual system of which the principal organizational elements are:

(1) A central control point operated by the NBC Unit located in or adjacent to the Division FSCC.

(2) NUDET ground and aerial observation and reporting posts established at selected locations and times throughout the command. Each NUDET ground observation and reporting post will utilize existing tactical and fire support observation posts and personnel wherever possible. Personnel required will be furnished by the unit responsible for establishing and operating the post. Aerial observation posts are established as required, using available aircraft. The installation, operation, and maintenance of communications for NUDET observation posts is the responsibility of the unit establishing the post.

b. Equipment—NUDET Observation Posts.

(1) *Ground observation posts.* Equipment

required for the operation of each ground observation post is as follows:

(1) Optical device listed below in order of preference.

(*a*) Aiming Circle, M2
(*b*) BC Scope, M65 or M43
(*c*) Theodolite, T16 or T2
(*d*) Pocket Transit or Compass, M2
1 Radio and/or Telephone
1 Watch with second hand
1 Stop Watch
1 Clipboard
25 NBC 1 Reports—Observer's Report

Units not authorized the equipment listed above will arrange through their appropriate supply channel for either the loan of the necessary equipment from other units within the command or the issue of the equipment as item(s) authorized in excess of current allowances.

(2) *Aerial observation posts.* Special equipment is not required for aerial observation posts. For both preplanned and immediate reconnaissance and surveillance missions, the NBC Unit will determine the type of sensor, that is, photographic, visual, radar, infrared, or television, required. The NBC Unit will request the aircraft through the FSCC.

c. Functions.

(1) *NBC Unit.* The following functions relative to the nuclear detonation data reporting system are performed by the NBC Unit:

(*a*) Prepares for assignment by G-2 a three-character, digits, letters, and/or combination thereof, observation post identifier to each observation post and subordinate command NBC Unit, if any, located in the command's area of responsibility.

(*b*) Maintains a current listing of observation post identifiers for all observation posts in the command and NBC Units of lateral and higher commands.

(*c*) Maintains a current plot of the surveillance capabilities of each observation post in the command area of responsibility. Recommends to G-2 the establishment and location of additional observation posts along with the units responsible for their operation whenever the surveillance plot indicates a need for such posts.

(*d*) Alerts the Air Officer in the FSCC during periods of inclement weather, poor visibility, or heavy cloud cover, which restricts or prevents surveillance by ground observation posts to the extent that more detailed aerial reconnaissance and surveillance effort is required.

(*e*) Prepares and disseminates, according to SOP, effective wind messages each time upper wind data are received. Messages are prepared as shown in TM 3-210.

(*f*) Prepares and disseminates fallout predictions for each friendly, enemy, or unidentified nuclear detonation. Fallout predictions are made as shown in TM 3-210.

1. For each friendly nuclear attack, the NBC Unit—

(a) Receives the planned yield, height of burst, and intended ground zero from the FSCC; prepares the fallout prediction for the FSCC (to be incorporated in the target analysis being prepared by that element).

(b) Arranges with the Division Air Officer for reconnaissance and surveillance of the burst area immediately after the detonation. Location of ground zero with respect to the FEBA, capabilities of NUDET observation posts to observe the detonation, and predicted visibility and cloud cover will influence the selection of aerial sensors for this mission.

(c) Receives, collates, screens, and evaluates all NBC 1 reports after a nuclear strike. Based on information given in these reports, determines the actual time of detonation and actual location of ground zero, and estimates the yield and type of burst.

(*1*) For preplanned fallout-producing bursts, a fallout prediction is prepared, based on predicted burst parameters and the latest upper air wind data. An NBC 3 report is disseminated alerting subordinate units, higher and lateral commands, and all elements of the FSCC. For fallout-producing bursts not originally predicted to produce fallout, a fallout prediction is prepared. An NBC 3 report is disseminated in the clear with FLASH precedence to those subordinate units and higher and lateral commands which are located in Zone I and Zone II, to all elements

of the FSCC, and to the next higher commands. All other units, as required by SOP or as directed by G–3, will receive an NBC 3 report disseminated in the clear with IMMEDIATE precedence.

(*2*) For reported air bursts, the NBC Unit determines the actual time of detonation and actual location of ground zero, estimates the yield, and then disseminates an NBC 2 report in the clear with IMMEDIATE precedence to all elements of the FSCC, higher and lateral commands, and subordinate units, as required by SOP or as directed by G–3.

(*3*) For bursts reported as unknown, disseminates the same information and in the same manner as for an air burst; prepares a fallout prediction based on actual burst parameters and an assumed surface burst, but withholds dissemination pending confirmation by NBC 4 reports or aerial observation that the burst is producing fallout. In this event, the NBC Unit disseminates with FLASH precedence in the clear an NBC 3 report to all subordinate units and higher and lateral commands, and to all elements of the FSCC.

2. For each enemy or unidentified nuclear detonation, the NBC Unit:

(a) Receives, collates, screens, and evaluates initial NBC 1 reports and determines time of detonation and location of ground zero; disseminates with FLASH precedence in the clear an initial NBC 2 report to all FSCC elements, and to higher and lateral commands and subordinate units as prescribed by SOP or as directed by G–3; requests through the FSCC an aerial reconnaissance and surveillance of ground zero. During periods of inclement weather, poor visibility, or cloud cover which reduce or eliminate the surveillance capabilities of NUDET ground observation posts, specifically requests an in-flight report on cloud-top height, cloud width, location of ground zero, and information on the presence or absence of a crater.

(b) Receives, collates, screens, and evaluates followup NBC 1 reports and prepares and disseminates NBC 2 followup reports to all FSCC elements, higher and lateral commands, and subordinate units as prescribed by SOP or as directed by G–3.

(c) For each positively identified fallout-producing burst, as determined from NBC 1 reports, disseminates in the clear with FLASH precedence, an intial NBC 3 report to those subordinate units, and higher and lateral commands which are located in Zone I and Zone II and to all elements of the FSCC and higher headquarters. The units to be notified are determined by use of actual ground zero and the fallout prediction plot used to prepare the latest effective wind messages. After receipt of followup NBC 1 reports, the NBC Unit prepares a fallout prediction using actual burst parameters and latest upper wind data available; then prepares and disseminates in the clear with IMMEDIATE precedence a followup NBC 3 report to all elements of the FSCC, higher and lateral commands, and subordinate units.

(d) Prepares a fallout prediction for all other bursts, except a positively identified high air burst, based on the assumption that the burst was a surface detonation and using actual burst parameters as determined from NBC 1 reports. Dissemination of the pre-prepared NBC 3 report is suspended pending confirmation of the presence of a crater by aerial observation or receipt of NBC 4 reports confirming that fallout is occurring. In this event the previously prepared NBC 3 report is disseminated in the clear with IMMEDIATE precedence to all higher and lateral commands, and all subordinate units.

(e) Prepares and displays an overlay showing the radii of immediate effects and obstacles, as calculated from actual burst parameters or as reported by ground and aerial observation. Procedures used are as shown in FMFM 11–4 and FMFM 11–4A (FM 101–31–1 and –2). Information shown on this display includes, but is not limited to—

(*1*) Probable minimum radius for prompt casualties to exposed personnel.

(*2*) Probable minimum radius for prompt casualties to protected personnel.

(*3*) Probable minimum radius of damage to wheeled vehicles.

(4) Probable minimum radius of damage to tanks and artillery.

(5) Radius and/or location of obstacles.

(f) Receives, collates, screens, evaluates, displays for use, and disseminates to subordinate units information on enemy, friendly, and unidentified nuclear detonations received from higher and lateral commands.

(g) Maintains a continuous record of burst parameters and the effects of each enemy, friendly, and unidentified nuclear burst which occurs in the command's areas of interest. Displays pertinent information as to location, obstacles created, and areas of contamination of all nuclear detonations which may affect current and future operations of the command.

(2) *NUDET observation posts.*

(*a*) *Ground observation posts.* Trained and equipped personnel manning ground observation posts observe, identify, measure, and record nuclear burst parameters from all nuclear detonations within the limits of visual observation, and report the pertinent observed data to the NBC Unit via the FSCC communications channels. Specific functions of NUDET observation post personnel are as follows:

1. Immediately after establishment of the NUDET observation post, report to the NBC Unit the location (encode) and observation capabilities.

2. Routinely report to the NBC Unit changes in observation capabilities caused by inclement weather, limited visibility, and cloud cover.

3. For each observed nuclear detonation, follow the procedure described in paragraph 2-5 (Sequence of Events) of this manual. Transmit the NBC 1 report to the NBC Unit, using FLASH precedence and transmitting in the clear.

(*b*) *Aerial observation posts.* Aerial reconnaissance and surveillance is performed over the ground zero area as soon as possible after each friendly, enemy, or unidentified nuclear detonation. For friendly preplanned and on-call nuclear strikes, the aerial reconnaissance and surveillance mission is preplanned. For friendly target-of-opportunity, enemy, and unidentified nuclear detonations, an immediate request is submitted by the NBC Unit to the FSCC for the aerial reconnaissance and surveillance mission. In both cases, in-flight reports are made through channels to the FSCC to expedite receipt of information obtained by aerial means. Aerial reconnaissance and surveillance requests are initiated by the NBC Unit and include as a minimum the following requirements:

1. During periods of good visibility—

(a) Time over target (preplanned missions only).

(b) Location of ground zero (coordinates and/or name of place).

(c) Presence or absence of a crater.

(d) Imagery coverage of the strike area (photographic, infrared, and so forth).

(e) Actual or estimated cloud-top height (state which).

(f) Visual observation and description of target area, to include estimates of radii of damage, obstacles created and their location(s), and the condition of units, installations, and facilities in the target area.

(g) In-flight reports (spot reports) by reconnaissance aircrews and other aircrews (such as fighter crew members).

2. During periods of restricted visibility and/or cloud cover which limit or preclude surveillance by ground observation posts—

(a) Time over target (preplanned mission only).

(b) Appropriate imagery coverage of the strike area to determine location of ground zero, presence or absence of a crater, description of target area, condition of installation and facilities in the target area, radius of damage, and/or obstacles created.

(c) Actual or estimated cloud-top height.

(d) Cloud width and time of measurement.

(e) In-flight reports (spot reports) by reconnaissance aircrews and other aircrews (such as fighter crew members).

E-4. Description of NUDET Standardized Reports

a. NBC 1 Report—Observer's Report.

(1) Examples of this report are shown in

paragraph 2–2 (The Nuclear Burst Report, NBC 1), in paragraph 2–3 (Example Nuclear Burst Reports), and in appendix C of this manual. This report will be used by the NBC Unit to pass a warning report to higher and lateral commands and subordinate units when the urgency of the situation and lack of sufficient data preclude the dispatch of the NBC 2 report described in *b* below.

(2) The following additional instructions apply when making an NBC 1 report:

(*a*) For line code ALFA use the five characters, digits, letters, or combination thereof which represents the observation post identifier and the strike serial number assigned by the observation post or NBC Unit. A three-digit observation post identifier is assigned by the G–2 to each observation post located in the command's area of responsibility. A higher headquarters also assigns a similar identifier to the NBC Unit of each subordinate command. The three-digit identifier is followed by the strike serial number, a two-digit number starting with 01, which is assigned by the observation post. Strike serial numbers are consecutive for each 24-hour reporting period beginning at 0001 hours. All followup NBC reports use the same strike serial number as the initial NBC report submitted on each burst.

(*b*) The initial NBC 1 report should include the DTG of the sighting, type of burst (air, surface or unknown), and information to locate ground zero. The location of assigned NUDET observation posts is known by the NBC unit and only line codes ALFA, DELTA, HOTEL, and either CHARLIE and JULIET (if measured) or FOXTROT (if known) are required in the initial report. Reports may be submitted by other than designated OP's and line BRAVO should be included in these reports.

(*c*) Transmit the initial sighting report in the clear with FLASH precedence, without delaying to obtain data to make a complete NBC 1 report.

(*d*) Transmit line code MIKE immediately after measurement of the angles. This is the followup NBC 1 report. Line codes ALFA and DELTA are always included in followup NBC 1 reports. Transmit in the clear with FLASH precedence.

(*e*) During periods when darkness, poor visibility, or cloud cover prevents observation of the nuclear cloud, as a minimum transmit type of report and line codes ALFA and JULIET. Transmit in the clear with FLASH precedence and do not dely transmission of the report to see if additional burst information may be obtained.

(3) The explanation of the line codes and recording instructions for the NBC 1 report are given in paragraph C–3 of this manual.

b. NBC 2 Report—NUDET Warning Report.

(1) This report, as shown in paragraph C–4 of this manual, will be used by the NBC Unit to transmit evaluated NUDET information to higher and lateral commands, and subordinate units. This report will be based on data contained in *at least two,* preferably more, NBC 1 reports. When the urgency of the situation and lack of data in NBC 1 reports prevent preparation of an NBC 2 report, the NBC Unit will disseminate an NBC 1 report to higher and lateral commands and subordinate units.

(2) The following instructions apply when making an NBC 2 report:

(*a*) Transmit the initial report in the clear with FLASH precedence and without delaying to obtain the data for the complete NBC 2 report.

(*b*) As a minimum, transmit the type of report and line codes ALFA, DELTA, and FOXTROT.

(*c*) Transmit a followup NBC 2 report including lines ALFA, DELTA, FOXTROT, HOTEL, and NOVEMBER as soon as this information is available.

(*d*) The followup report should be transmitted with PRIORITY precedence to higher, lateral, and subordinate commands.

c. NBC 3 Report—Fallout Warning Report.

(1) This report is shown in paragraph C–5 of this manual.

(2) The following instructions apply when making an NBC 3 report for a preplanned nuclear strike, an on-call nuclear strike, or a nuclear strike on a target of op-

portunity from which fallout is expected to occur:

(*a*) Transmit with appropriate precedence, depending on the type strike and time available, line codes ALFA, DELTA, FOXTROT, YANKEE, and ZULU.

(*b*) Security requirements of the transmission will be dependent upon the time available, method of transmission, location of the units to be affected, and the tactical situation. Unless otherwise directed by G–2/G–3, minimum security for radio transmission is EFTO (encrypted for transmission only).

(*c*) Information to complete line codes DELTA and FOXTROT is provided to the NBC Unit by the FSCC. Line codes YANKEE and ZULU are determined by the NBC Unit and are based on the latest upper air wind data available or predicted, and information furnished by the FSCC.

d. NBC 4 Report—Radiation Dose Rate. This report is shown in paragraph C–6 of this manual. The nuclear radiation dose rate report is used by radiation monitors and survey parties for recording and reporting radiological contamination information to the NBC Unit. Radiological monitoring and survey operations are beyond the scope of this appendix and are not discussed further.

e. NBC 5 Report—Nuclear Contamination. This report is shown in paragraph C–7 of this manual. This report is used by the NBC Unit to transmit or exchange radiological contamination information with higher, lateral, and subordinate commands.

f. Other Reports.

(1) *Effective Wind Message.* The NBC Unit prepares and disseminates to subordinate headquarters effective wind messages each time upper air wind data are received. Procedures for the preparation and dissemination of effective wind messages are contained in TM 3–210.

(2) *Upper Air Wind Data.* Upper air wind data for fallout prediction are used only by the NBC Unit and are normally obtained from artillery meteorological sections, Marine Aircraft Wing elements, or Air Weather Service (AWS) detachments with air force installations. Upper air wind data are also available from U.S. Army CBR Elements and artillery units and Navy staff meteorologists when the NBC Unit is still afloat. The requirements and procedures for receipt and use of these data are contained in TM 3–210 and FM 6–15.

Section II. THE DIVISION

E–5. Introduction

This section lists the units which establish, equip, and operate the primary and alternate NUDET ground observation posts in the division area, the communications used by the ground and aerial observation posts to transmit NUDET reports to the NBC Unit, the procedures used in the NBC Unit to obtain aerial reconnaissance and surveillance of a nuclear strike, and the communications used to transmit NUDET warnings to higher and lateral commands and subordinate units.

E–6. Ground Observation

a. Responsibilities.

(1) The G–2 shall insure observation throughout the division zone of action by designating those units required to equip and operate NUDET observation posts. If appropriate, subordinate Commanders may be designated by the Division Commander to determine specific units for this purpose.

(2) The artillery regiment will be the primary source of such observation and shall be prepared to designate sufficient trained forward observers, battalion and regimental observation posts, and firing batteries to insure observation throughout the assigned areas of responsibility.

(3) When appropriate, other combat and combat support units such as infantry regiments/battalions, reconnaissance units, and the tank battalion may be required to equip and operate NUDET observation posts to the flanks and forward of the FEBA, or to cover selected areas under marginal observation by other units.

(4) When the above units are unable to provide observation throughout the division

rear area, and/or to augment existing observation, selected combat service support units such as shore party battalion and the force service regiment (FSR) may be required to establish, equip, and operate additional NUDET observation posts.

b. Equipment. See paragraph E-3*b*.

c. Communications.

(1) Communications relating to observation and reporting will utilize the facilities designated in Tab A to this appendix.

(2) Communications from Division to higher headquarters and/or adjacent headquarters will be by the most expeditious available means, using appropriate precedence.

E-7. Aerial Observation

All requests by the NBC Unit for aerial observation will be made to the FSCC, which will fill the request with resources under its immediate control or will pass the request to the appropriate aviation element.

E-8. Dissemination of NUDET Information

a. Responsibilities.

(1) The NBC Unit is responsible for disseminating, according to SOP or as directed by G-2/G-3, effective wind messages and NUDET reports to subordinate units and higher headquarters.

(2) The FSCC is responsible for disseminating STRIKEWARN messages (para 4.6, FMFM 11-4) to higher headquarters, to subordinate and lateral commands, and to all NUDET observation posts. The NBC Unit will provide to the FSCC a list of NUDET observation posts to be alerted for each planned nuclear strike.

b. Communications.

(1) As designated in Tab A to this appendix.

(2) The FSCC will notify the Marine Aircraft Wing via the DASC.

(3) The FSCC will notify higher commands, utilizing the most expeditious command or alert communication channel.

Section III. THE MARINE AIRCRAFT WING

E-9. Introduction

This section relates to integration of MAW elements into the NUDET system. Since the organization of the MAW and location of various elements thereof is highly flexible, designation of specific observation/reporting units is considered to be a matter of coordination between the Wing and Division G-2, or as directed by the common superior. Those elements of the Wing located within the general area of observation/reporting already under the cognizance of the Division will be routinely included by the Division plan of observation. Elements outside of the Division plan will establish the necessary observation posts as directed by the Wing G-2 and coordinated with the Division G-2 as appropriate.

E-10. Ground Observation

a. Responsibilities. The Wing G-2 shall insure observation by designating those units required to equip and maintain NUDET observation posts. In coordination with the Division G-2, or as directed by MAW CG or common superior, the Wing G-2 will establish observation posts to augment those established by the Division, to cover dead spaces relating to Wing installations.

b. Equipment. The Wing G-2 will arrange for provision of essential items of equipment listed in paragraph E-3*b*.

TAB A TO APPENDIX E

COMMUNICATIONS

1. *Primary Collection Agencies.* The Artillery Forward Observer and the airborne observer are normally the first source of NUDET reporting. Both have available radio nets for rapid transmission of their observations. Since the infantry battalion and the infantry regimental FSCC monitor the Direct Support Artillery Battalion Conduct of Fire Net, this radio

channel is the ground forces primary means of reporting. The Artillery Battalion FDC will retransmit on the Artillery Regiment's Fire Direction Net to the Division FSCC. Alternate means are available through the hot line or switchboard trunk lines of the Division wire-radio relay system. The Airborne Observer may use the Division Air Observation Net or the Tactical Air Observation Net for reporting. These channels terminate at the Division CP and Tactical Air Command Center, respectively. The Direct Air Support Center which is located in close proximity to the Division FSCC monitors the Tactical Air Observation Net.

2. *Combat and Combat Service Support Elements.* Units not employing the services of a Direct Support Artillery Battalion will report NUDET information on the Division Tactical or Division Command Net #2. Though the Division Command Net terminates in the Communication Center at the Division CP, minimum time delay in passing this information to the Division FSCC can be expected. Alternate means would be use of the Division wire-radio relay system to report direct to the FSCC. Figures E-1 and E-2 illustrate the flow of NUDET information via designated ground communications nets.

3. *Dissemination of Information.* All units of battalion size or larger routinely maintain a radio receiver on the Division Alert/Broadcast Net. Warnings and information requiring the widest dissemination without regard to clasification safeguards can be passed on this channel. The Division Communication Center can provide covered channels of communication to all units of the Division that will deny disclosure of the information transmitted to enemy intercept. Such information that does not warrant a security classification, but is sensitive in nature, can be encrypted for transmission only (EFTO).

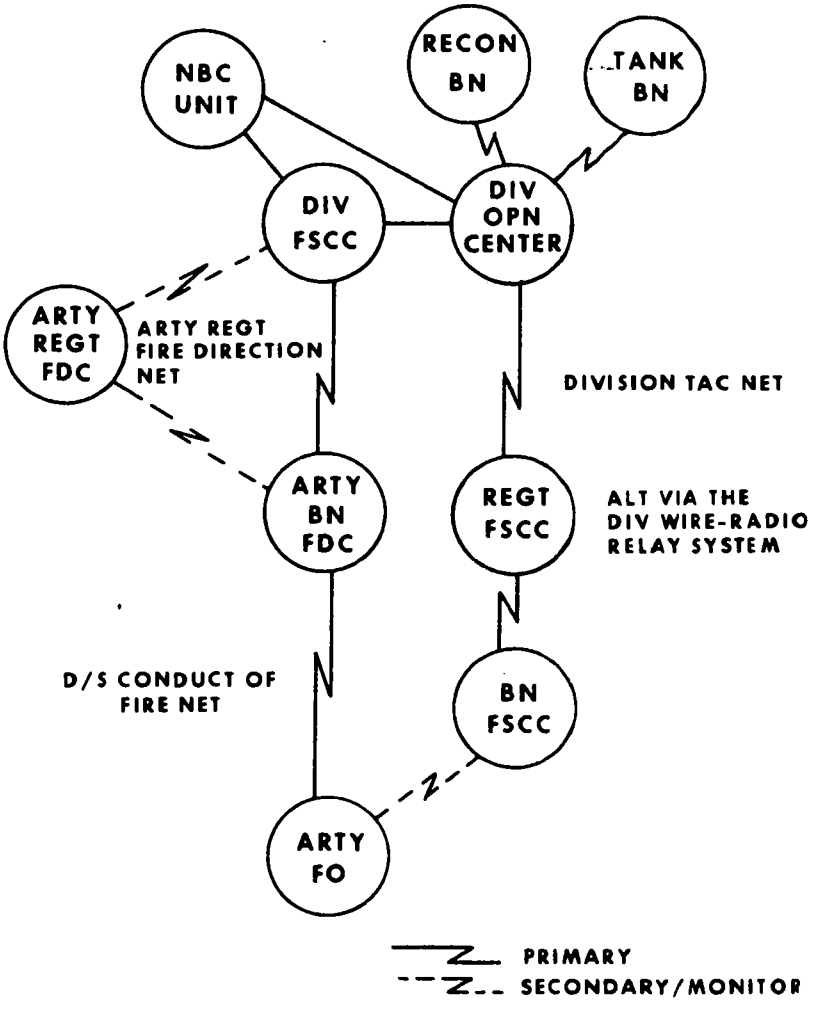


Figure E-1. NUDET communications nets (combat units).

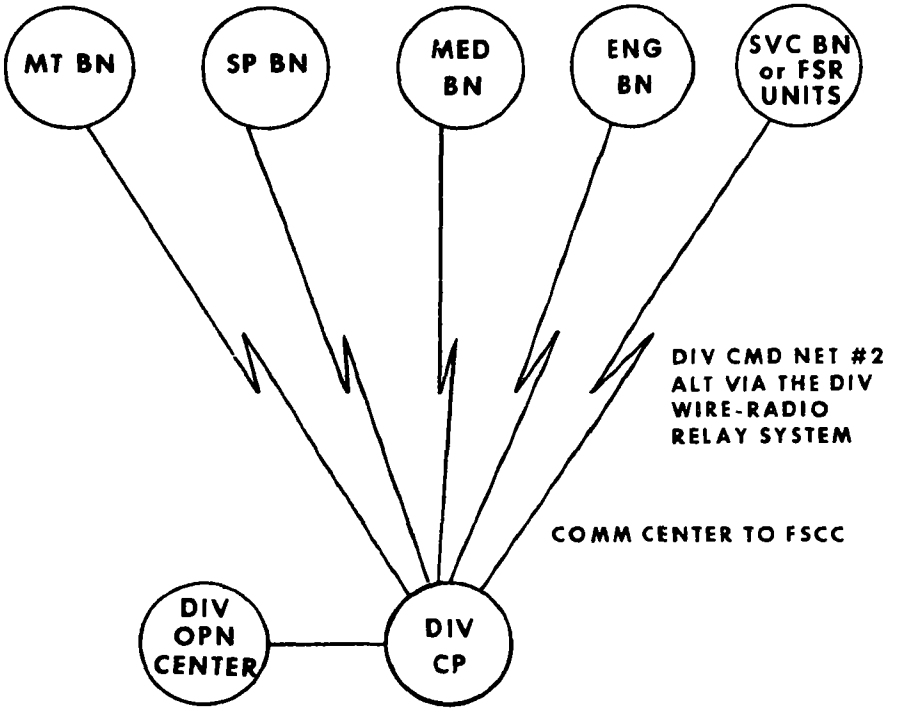


Figure E-2. NUDET communications nets (combat service support units).

APPENDIX F
OPTIMUM TIME FOR EXIT OF FALLOUT AREAS

F-1. General
Radiological fallout may present a serious radiological hazard to units that remain in the contaminated area. The efficient use of shelters such as field emplacements will provide the best protective measures against nuclear radiation for troops in the field. If the shelter provides any appreciable amount of protection, it will generally be advantageous to remain in the shelter and improve it rather than to attempt to evacuate to an uncontaminated area. However, if the situation permits, and with approval of higher headquarters, the commander may decide to move out of the radiologically contaminated area. By evacuating the contaminated area at the optimum exit time, the radiation dose to personnel will be kept to a minimum under the circumstances.

F-2. Input Data Required
To compute the optimum exist time from a fallout area, the following information must be known:

a. Time of Detonation. The time of detonation of the nuclear weapon that produced the fallout on the unit's position must be known. If the nuclear burst was not sighted by the unit, the H-hour will be provided by the nearest CBRE.

b. Location of Uncontaminated area. When moving from a fallout contaminated area, the unit should move to an uncontaminated location. This will necessitate waiting until fallout is complete on the present and the future positions.

c. Average Transmission Factor. The average transmission factor of the fallout shelters and the vehicles used to leave the contaminated area should be computed. If data are not available, use figure 5-3. Since all shelters will not be the same, an average value should be used. The transmission factor of a vehicle may be estimated, using the values in figure 5-3. A unit moving on foot will be fully exposed and have a transmission factor of 1.0.

d. Time to Evacuate the Area. The time to load on vehicles and move out of the contaminated area must be estimated. In order to minimize exposure time, it may be necessary to temporarily abandon nonessential items and recover them at a later time when the dose rate has decayed to a low value.

F-3. Abbreviations
The following abbreviations are used in the exit time computations:

A_s = Average transmission factor for the fallout shelters.

A_e = Average transmission factor after leaving shelters during movement out of the area.

T_{ev} = Time (in hours) required to move out of the contaminated area.

F-4. Computations
The optimum exit time is computed by the three following steps:

a. Calculate the Transmission Factor Ratio $\frac{A_s}{A_e}$. Divide the average transmission factor for the fallout shelters (A_s) by the average transmission factor during evacuation of the area (A_e).

b. Determine the Multiplication Factor. Enter the vertical axis of figure F-1 at the value determined in *a* above. Move horizontally along the $\frac{A_s}{A_e}$ value to the curve. Move straight down to horizontal axis and read the multiplication factor.

c. Calculate the Optimum Exit Time. Multiply the multiplication factor by the evacua-

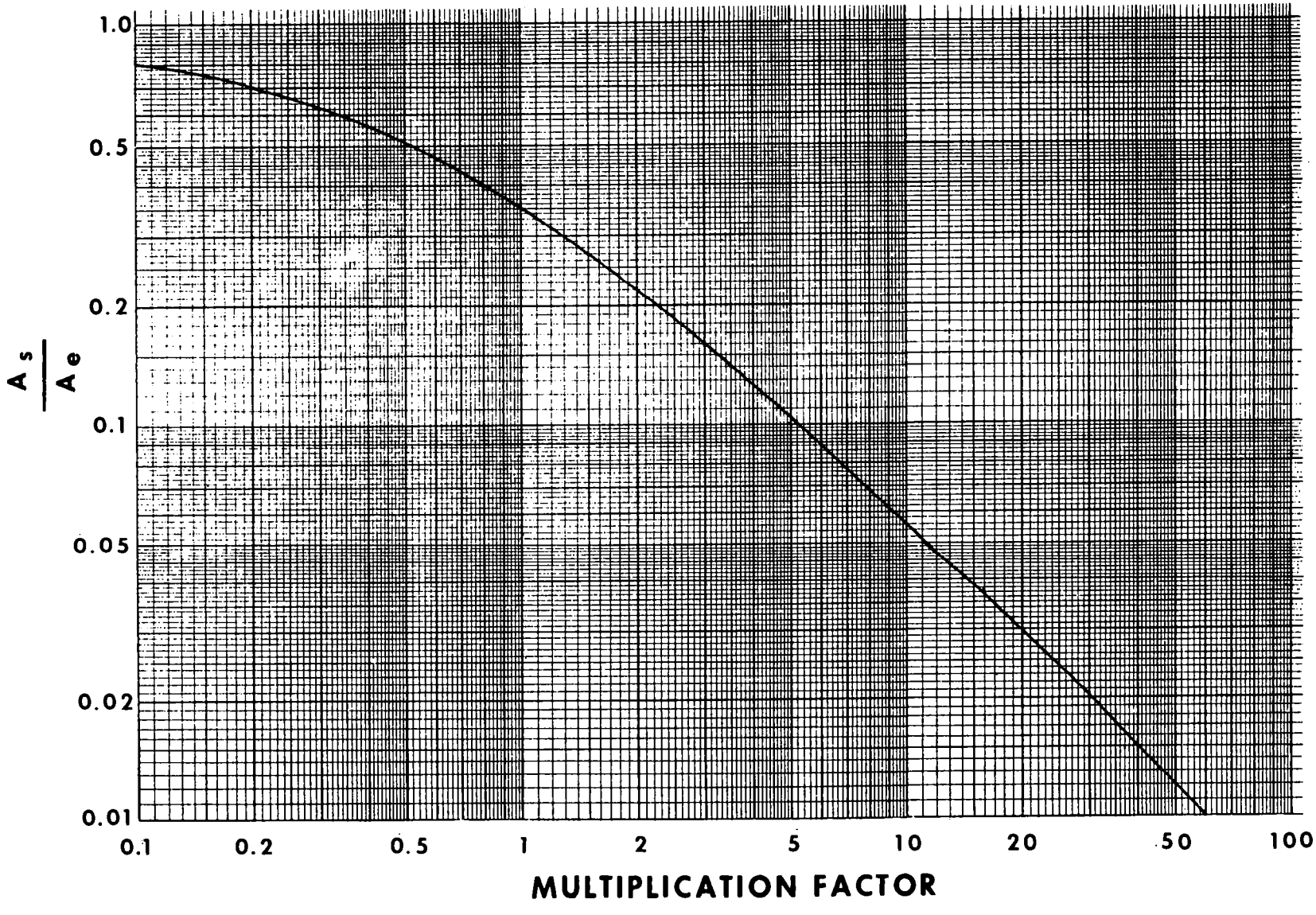


Figure F-1. Multiplication factor graph.

tion time (T_{ev}). The product is the optimum time, in hours after detonation, that the unit should leave its shelters and evacuate the area.

Mathematically, this can be expressed as—

Optimum exit time =
Multiplication factor $\times$ T_{ev}.

F–5. Special Considerations

a. For ratios of $\frac{A_s}{A_e}$ that are close to or greater than 0.5, the unit should evacuate the fallout area as soon as possible.

★*b.* If the optimum exit time is estimated to be before the actual arrival of fallout, the unit should evacuate the area as soon as possible after fallout is complete and an uncontaminated area is available.

★*c.* Leaving the contaminated area at the optimum time will result in the smallest dose possible received by the unit. If the unit commander is willing to accept up to a ten percent increase in dose above the minimum possible dose, he may leave the shelters any time between one-half and twice the optimum time.

★*d.* If possible, personnel should improve their shelters while waiting for the optimum exit time. The estimate of the optimum exit time should be recalculated if significant improvement is made in the shelters. Improved shelters will mean that the unit should remain in shelters for a longer period of time to minimize the dose to the personnel.

F–6. Sample Problem

GIVEN.

$A_a = 0.1$ (foxhole).

$A_e = 0.6$ (2½-ton truck).

$T_{ev} = 1$ hour.

FIND. Optimum exit time.

SOLUTION. $\frac{A_s}{A_e} = \frac{0.1}{0.6} = 0.167$.

Multiplication factor = 2.80.

Optimum exit time =
multiplication factor $\times$
$T_{ev} = 2.80 \times 1 = 2.80$,
or about H + 3 hours.

Note. The unit may depart between H + 1.5 and H + 6 hours without a significant increase in dose to the personnel.

APPENDIX G

OVERLAPPING FALLOUT PATTERNS

G-1. General

It is highly probable that there will be areas on the battlefield which will be subject to fallout from more than one detonation. Procedures for predicting future dose rates in areas contaminated by single explosions (para 5-2 and 5-9) are not adequate in many instances for predicting future dose rates within overlapping fallout patterns. Fallout produced by more than one explosion will normally have different decay exponents at different locations within the area. Procedures for predicting future dose rates within overlapping fallout patterns are presented in this appendix. In addition, a simple rule is presented for designating the relative hazard when two or more fallout *predictions* overlap.

G-2. Dose-Rate Calculation Methods

The methods described below are applicable to *two or more* overlapping fallout patterns. The choice of method is dependent upon whether enough is known about each burst to separate the dose rates contributed by each.

a. Sufficient Information Known to Permit Separation of Different Contributions.

(1) Separate the contributing dose rates. This step requires that H-hour of each burst be known and that two or more dose-rate readings be available for the location of interest after the fallout from each contributor peaks and prior to the arrival of new fallout. Normal procedures for calculating the decay exponent (n) for each contributor at the location of interest are used (para 7-18).

(2) Calculate the total dose rate for a specific location at any time in the future by calculating the dose rate at the desired future time for each contributor separately (para 5-2 and 5-9*b*) and adding the results.

(3) Repeat (1) and (2) for *each* location of interest within the overlapping fallout patterns.

b. Insufficient Information Known to Permit Separation of Different Contributions.

★(1) For a specific location, on log-log graph paper plot the *latest* two dose-rate measurements (after final fallout peak) against time after the latest detonation. This step requires two or more dose-rate measurements at that location after final fallout peak as well as a knowledge of the time of the latest detonation. (If the time of the latest detonation is unknown, estimate H-hour as the time of the latest known burst.)

(2) Draw a straight line through these points and extrapolate the line to later times.

(3) Determine a first approximation of the future dose rate directly from the graph.

(4) Plot a later dose-rate measurement at that location when it becomes available.

(5) Draw a straight line through the new latest two points and extrapolate the line to later times.

(6) Determine a better approximation of the future dose rate directly from the latest extrapolation.

(7) Repeat (4), (5), and (6) as later dose-rate measurements as that location become available.

(8) Repeat (1) through (7) for *each* location of interest within the overlapping fallout patterns.

G–3. Fallout Predictions

The actual procedures for preparing fallout predictions are given in TM 3–210 and do not change as a result of the possibility that predicted hazard zones may overlap. However, if overlap does occur, the following rule applies: *The hazard classification of an area where predicted fallout hazard zones overlap should be only that of the higher classification involved.* That is, an overlap area involving Zone I should be designated Zone I, and an overlap area involving nothing more hazardous than Zone I–A should be designated Zone I–A. An area involving nothing more hazardous than Zone II should be designated Zone II. For an example of this rule, see figure G–1.

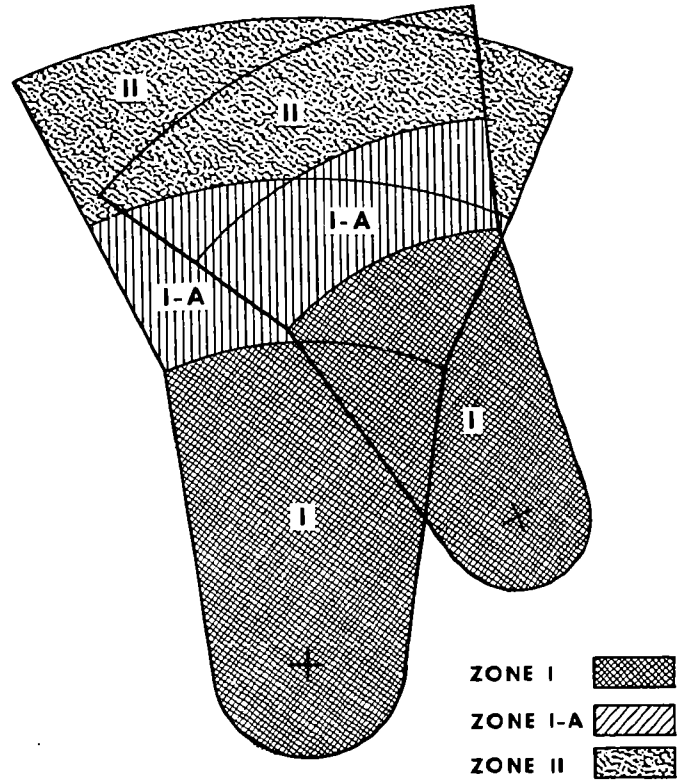


Figure G–1. Overlapping fallout predictions.

G–4. Examples of Dose-Rate Calculation Methods

a. Example Problem 1. At a location where fallout has been received from two detonations, one at 0800 hours and one at 1100 hours, the following dose rate readings were recorded:

Time	*Dose rate (rad/hr)*
0830	160
0900	100
0930	61
1000	44
1100	27
1130	462
1200	219
1300	108

Predict the dose rates at this location for 0800 hours 24 and 48 hours after the first burst.

b. Solution. Sufficient data are available to separate the two contributors. Therefore, the method described in paragraph G–2*a* is used.

(1) Separate the two contributing dose rates. An examination of the measured dose rates indicates that the fallout from the first burst peaked prior to H + 1 hour (0900). The reference dose rate (R_{1x}) for this portion of the fallout would be 100 rad/hr. The fallout from the second burst peaked prior to H + 1 hour for the second burst (1200); thus the reference dose rate (R_{1y}) for this portion would be 219 rad/hr minus the contribution from the first burst. Using the procedure described in paragraph 7–18*e* of FM 3–12, calculate the decay exponent (n_x) for the first contributor.

$$n_x = \frac{\log\left(\frac{R_{1x}}{R_{3x}}\right)}{\log\left(\frac{T_{3x}}{T_{1x}}\right)} = \frac{\log\left(\frac{100}{27}\right)}{\log\left(\frac{3}{1}\right)} = 1.19 = 1.2$$

Then R_{4x} (1200) would be 19 rad/hr as determined from figure 5–1. Therefore, R_{1y}, the reference dose rate for the second contribution, would be 219 − 19 = 200 rad/hr. Calculate the decay exponent (n_y) for the second contributor.

$$ny = \frac{\log\left(\frac{R_{1y}}{R_{2y}}\right)}{\log\left(\frac{T_{2y}}{T_{1y}}\right)} = \frac{\log\left(\frac{200}{108-14}\right)}{\log\left(\frac{2}{1}\right)} = 1.07 = 1.1$$

(2) Calculate the total dose rate for 0800 hours 24 hours after the first burst by finding the dose rate for that specific time for each contributor separately; then add the two values. Using figure 5–1—

R_{24x} = 2.2 rad/hr (R_{1x} = 100 rad/hr; n = 1.2)
R_{21y} = 7.4 rad/hr (R_{1y} = 200 rad/hr; n = 1.1)
R_{total} = 9.6 rad/hr

(3) Calculate the total dose rate for 0800 hours 48 hours after the first burst by finding the dose rate for that specific time for each contributor separately; then add the two values. Using figure 5–1—

R_{48x} = 0.95 rad/hr (R_{1x} = 100 rad/hr; n = 1.2)
R_{45y} = 3.15 rad/hr (R_{1y} = 200 rad/hr; n.= 1.1)
R_{total} = 4.1 rad/hr.

This method is exact; thus these values represent the actual values.

c. Example Problem 2. At a location where fallout has been received from two detonations, dose rate measurements were made at intervals as shown below. The time of the second burst is at 0800 hours.

Time	*Dose rate (rad/hr)*
0900	360
1100	165
1300	108
1500	80
0200	30
1200	17.5

After receipt of the measurement made at 1100 hours, predict the dose rate at that location at 2000 hours on the following day (36 hours after the burst). After receipt of each succeeding dose-rate measurement, update this prediction.

d. Solution. Sufficient data are not available to separate the two contributors, but enough is known to use the method described in paragraph G–2*b*.

(1) Plot on log-log graph paper the 0900 and 1100 dose rate measurements against time after second burst.

(2) Draw a straight line through these points and extrapolate the line past H + 36 hours.

(3) As a first approximation, determine a dose rate of 28.0 rad/hr for 2000 hours on

the day following the burst (R_{36}) directly from the graph.

(4) Upon receipt of the 1300 measurement, plot this reading on the graph.

(5) Draw a new straight line through the 1100 and 1300 points and extrapolate the line past H + 36 hours.

(6) As a second (and better) approximation, determine a dose rate of 20.5 rad/hr for H + 36 hours directly from the second extrapolation.

(7) Repeating the procedure described in (4) through (6) above upon receipt of the 1500, 0200, and 1200 measurements, the prediction for R_{36} is updated to 18.0, 14.5, and 12.5 rad/hr, respectively.

(8) See figure G–2 for an illustration of the above procedures. Reading from this figure, the true dose rate encountered at H + 36 hours at that location is about 12.0 rad.

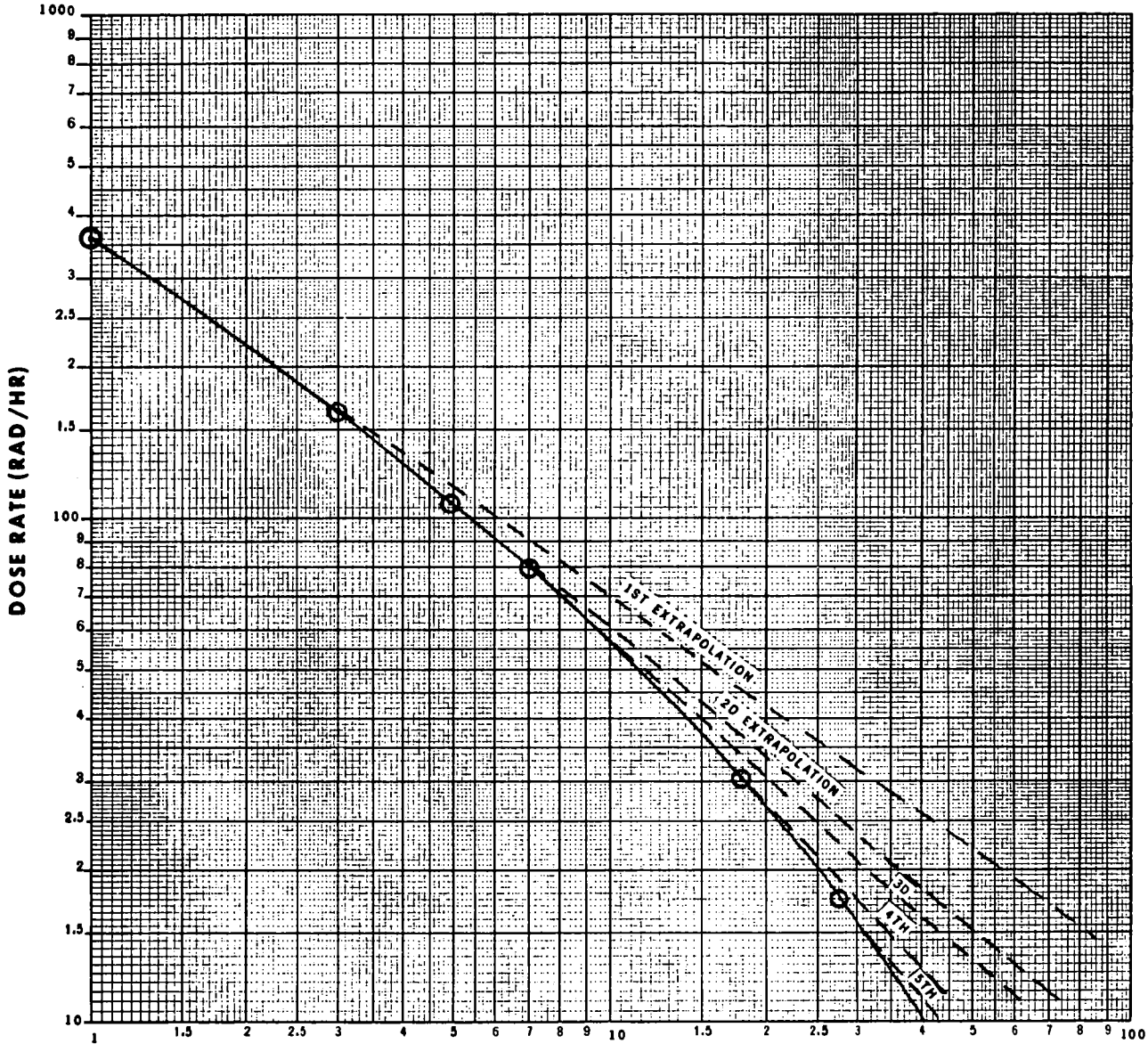
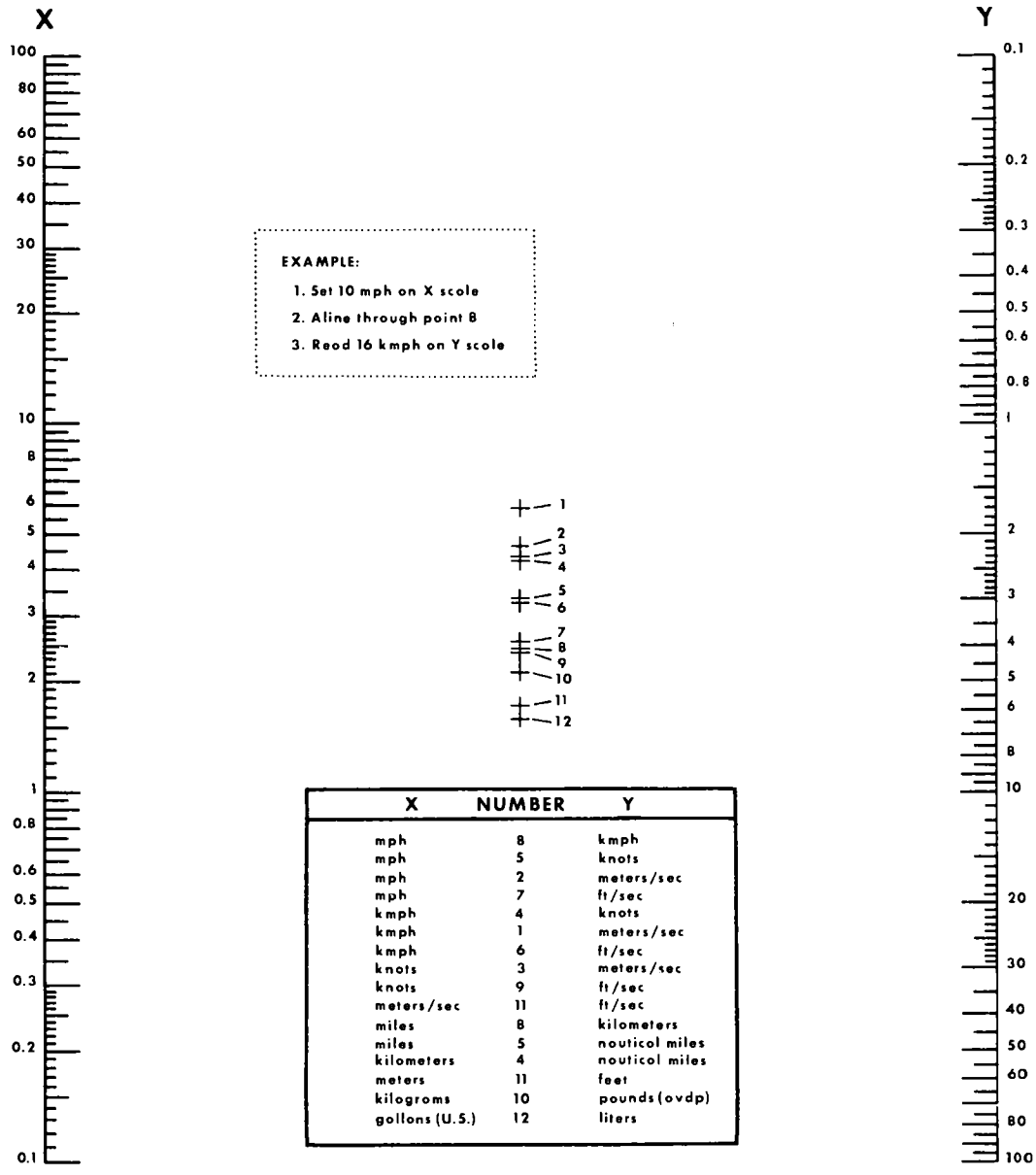


Figure G-2. Extrapolation method, with periodic revisions.

★APPENDIX H

CONVERSION SCALE



X	NUMBER	Y
mph	8	kmph
mph	5	knots
mph	2	meters/sec
mph	7	ft/sec
kmph	4	knots
kmph	1	meters/sec
kmph	6	ft/sec
knots	3	meters/sec
knots	9	ft/sec
meters/sec	11	ft/sec
miles	8	kilometers
miles	5	nouticol miles
kilometers	4	nouticol miles
meters	11	feet
kilograms	10	pounds(avdp)
gallons (U.S.)	12	liters

INDEX

	Paragraph	Page
Aerial reconnaissance	2–6	2–3
Aerial survey. (*See* Radiological survey.)		
Airborne radioactivity	4–5	4–2
Aircraft. (*See* Radiological survey.)		
Average dose rate	5–6, 5–15*b*	5–7, 5–20
Burst. (*See* Nuclear burst.)		
Calculator:		
Nuclear yield, M4	2–12	2–11
Radiac, ABC-M1	5–7	5–9
Chemical, biological, and radiological element (CBRE):		
Assumptions	7–2	7–1
Capability	7–2*b*, 7–3*b*	7–1
Chief or director	7–3*c*	7–2
Coordination	7–1	7–1
Duties	7–3*c*(2)	7–2
Mission	7–1	7–1
Operations:		
Calculations:		
Correlation factors. (*See* Correlation factor.)		
Dose. (*See* Dose; Fallout, Calculations; Induced radiation.)		
Dose rate (*also* see Fallout, Calculations; Induced radiation):		
Decay rate determination (H-hour known)	7–18*a*, *d*, *e*	7–9, 7–10, 7–12
Ground	1–8, 7–9, 7–20, 7–26*a*	1–4, 7–5, 7–13, 7–18
H-hour determination. (*See* H-hour determination.)		
H-hour estimates	7–9	7–5
Normalized	7–21, 7–26*b*	7–16, 7–18
Fallout prediction. (*See* Fallout prediction.)		
Fallout prediction message. (*See* Fallout prediction message.)		
Normalizing factor determination	7–21*a*, *b*, *c*	7–16
Overall correction factor	7–22	7–16
Plotting:		
Contamination overlays	1–9*b*, 7–29—7–33	1–4, 7–20
Contamination plots	7–29	7–20
Contamination worksheet overlays	7–24, 7–26, 7–31	7–18, 7–20
Contour lines	7–28—7–30	7–19
Monitoring and survey data	7–23—7–30	7–17
Radiological situation map	7–9*b*, 7–23	7–6, 7–17
Wind vector plots	7–5*b*	7–3
Processing of information	7–9	7–5
Time of completion of fallout. (*See* Fallout.)		
Concept	7–4, 7–7	7–3, 7–4
Estimation of situation	7–11	7–6
Organization	7–3	7–1
Planning radiological surveys	7–12	7–6
Processing of information	7–9	7–5

	Paragraph	Page
Records:		
Equipment status	7–5*g*	7–3
Nuclear burst	1–11*c*, 7–5*c*	1–8, 7–3
Radiation exposure status	6–9	6–6
Training status	7–5*g*	7–3
Supervision	7–1, 7–2*b*, 7–3*c*	7–1, 7–2
Support	1–11, 7–1, 7–3	1–7, 7–1
Chemical officer:		
Responsibilities	4–9*a*, 7–3*c*	4–5, 7–2
Supervision of CBRE	7–2*b*	7–1
Cloud. (*See* Nuclear burst cloud.)		
Command and staff responsibilities for collection efforts	1–11	1–7
Contamination, radiological:		
Acceptable levels	3–16*b*	3–7
Agents	1–3*a*(8), 5–8*b*, 7–6*d*	1–2, 5–10, 7–3
Airborne	4–5	4–2
Area:		
Crossing. (*See* Crossing contaminated areas.)		
Fallout. (*See* Fallout area.)		
Large-area. (*See* Large-area contamination.)		
Marking	5–17—5–20	5–21
Neutron-induced. (*See* Induced radiation.)		
Classification	7–8	7–4
Detected	7–8*b*	7–4
Dissemination of information	7–9*c*	7–6
Evaluated	7–8*c*	7–4
Fallout. (*See* Fallout; Fallout area.)		
Food. (*See* Monitoring.)		
Forms of information	1–10	1–7
Hot spots	7–29*a*	7–20
Induced. (*See* Induced radiation.)		
Information flow	1–11	1–7
Intelligence:		
Dissemination	7–34	7–22
Types	1–9	1–4
Use	1–12	1–8
Materiel. (*See* Monitoring.)		
Militarily significant:		
Contamination. (*See* Militarily significant contamination.)		
Fallout	1–9*a*, 7–2	1–4, 7–1
Neutron-induced	1–3*a*(2), 5–10, 5–11, 5–12, 5–15 7–8*b*, *c*	1–1, 5–14, 5–20, 7–4
Monitoring. (*See* Monitoring.)		
Overlapping. (*See* Overlapping fallout.)		
Overlays	1–9*b*, 7–24, 7–34	1–4, 7–18
Personnel. (*See* Monitoring.)		
Plotting	7–23—7–30	7–17
Presentation of information	7–31—7–34	7–20
Responsibilities for information collection	1–11	1–7
Sources	7–6	7–3
Survey. (*See* Radiological survey.)		
Suspected	7–8*a*	7–4
Transmission of information:		
Fallout prediction. (*See* Fallout prediction.)		
Fallout warning	app B	B–1
Monitoring reports	3–11—3–13, app C	3–4, C–1

	Paragraph	Page
Warning (other than fallout)	app B	B-1
Water. (*See* Monitoring.)		
Contour line:		
Determination	7-28	7-19
Dose rate	7-29	7-20
Drawing considerations	7-30	7-20
Militarily significant contamination:		
Fallout	1-9*b*, 7-8*c*	1-4, 7-4
Neutron-induced	5-12*b*, 7-8*b*, *c*	5-15, 7-4
Plotting	7-28—7-30	7-19
Correction factor	5-9	5-10
Correlation factor:		
Air-ground	4-10, 4-11,4-14	4-6, 4-7
Data required	3-5, 3-6*b*, 4-11	3-2, 4-6
Explanation	7-20	7-13
Published	4-11*b*, 4-20*b*	4-6, 4-10
Requirement	3-6*a*, 4-11, 4-21	3-2, 4-6, 4-10
Use	3-6*b*, *c*, 4-11, 4-17, 4-20, 7-20	3-2, 4-6, 4-9, 4-10, 7-13
Correlation factor data:		
Air-ground (*See* Correlation factor, Air-ground.)		
Location of survey meter. (*See* Survey meter, Location.)		
Procedure for obtaining	3-6*b*, *c*, 4-21*b*	3-2, 4-10
Procedure for obtaining air-ground correlation factor	4-10, 4-11	4-6
Recording	3-15, 4-13	3-5, 4-7
Reporting	3-11, 3-14,4-13*b*	3-4, 3-5, 4-7
Required	3-6*a*, *b*, 3-11*b*	3-2, 3-4
Requirement for	3-5*a*, 4-21*a*	3-2, 4-10
Use	4-21	4-10
Crossing contaminated areas:		
Fallout areas	5-6	5-7
Induced radiation areas	5-15	5-20
Decay:		
Fallout:		
Calculations:		
Correction factors	5-9	5-10
Dose	5-2, 5-3, 5-5, 5-9*b*, *c*	5-1, 5-3, 5-5, 5-13
Dose rate	5-2, 5-9*a*	5-1, 5-10
Exponent	5-2*a*	5-1
Nonstandard (*also see* CBRE, Operations, Calculations)	5-2, 5-8, 5-9	5-1, 5-10
Standard	5-2	5-1
Description	5-13*a*	5-15
Induced radiation:		
Calculations	5-13, 5-14	5-15, 5-19
Description	5-13*a*	5-15
Nonstandard (*also see* CBRE, Operations, Calculations)	5-8	5-10
Standard	5-2, 5-8	5-1, 5-10
Detonation. (*See* Nuclear burst.)		
Dose:		
Measurement. (*See* Rad.)		
Rate	1-8, 3-5, 5-2	1-4, 3-2, 5-1
Total. (*See* CBRE, Operations, Calculations; Fallout, Calculations; Induced radiation.)		
Dosimeter, pocket. (*See* Radiacmeter.)		
Effective downwind message	app B, app C	B-1, C-1
Estimate of the situation	7-11	7-6

	Paragraph	Page
Explosion. (*See* Nuclear burst.)		
Fallout:		
Calculations (*also see* CBRE, Operations, Calculations):		
Dose:		
Nonstandard decay	5–9*b*, *c*	5–13
Shielded	5–5, 5–6*f*	5–5, 5–8
Standard decay	5–2	5–1
Total	5–3, 5–5, 5–6*d*, *e*, *f*	5–3, 5–8
Dose rate:		
Average	5–6*c*	5–8
Crossing problems	5–6*e*, *f*	5–8
Maximum	5–6*c*	5–8
Nonstandard decay	5–9*a*	5–10
Normalized	5–6*e*, *f*	5–8
Shielded	5–5, 5–6*f*	5–5, 5–8
Standard decay	5–2	5–1
Decay. (*See* CBRE, Operations, Calculations; Decay, Fallout.)		
Decay exponents. (*See* CBRE, Operations, Calculations; Decay, Fallout.)		
Detected	7–8*b*	7–4
Evaluated	1–4, 7–8*c*	1–2, 7–4
Influence on operations	1–4, 5–1	1–2, 5–1
Overlapping (*See* Overlapping fallout.)		
Prediction. (*See* Fallout prediction.)		
Prediction message. (*See* Fallout prediction message.)		
Suspected	7–8*a*	7–4
Tactical impact	7–2*a*	7–1
Time-of-arrival calculations	7–17	7–9
Time of completion	7–17	7–9
Fallout area:		
Average dose rate in crossing	5–6	5–7
Calculations of dose in crossing	5–6*e*, 5–9	5–8
Calculations of dose after H + 24 hours	5–3*e*	5–5
Description	1–5*a*	1–3
Operations	5–1	5–1
Optimum time for exit	app F	F–1
Perimeter of militarily significant	7–8	7–4
Time of entry	5–3, 5–6	5–3, 5–7
Time of exit	5–9*b*	5–13
Time of stay	5–3, 5–6	5–3, 5–7
Fallout prediction	1–9*a*, 1–10*a*, 1–12, 2–7, app B	1–4, 1–7, 1–8, 2–4, B–1
Fallout prediction message	app B, app C	B–1, C–1
Fallout predictor. (*See* Simplified fallout predictor.)		
Flash-to-bang time:		
General	2–8*b*	2–4
Reporting	2–5	2–3
Use for estimation of location of ground zero	2–8*b*	2–4
Use for estimation of yield	2–10	2–7
Ground dose rate:		
Conversion of shielded dose rates to:		
Aerial	4–9*a*, *b*, 4–11, 7–26*b*	4–5, 4–6, 7–18
Ground	3–6, 4–17, 7–20, 7–26*a*	3–2, 7–13, 7–18
Requirement	1–8*a*, 3–5, 3–6*a*, 4–9*a*, 7–9, 7–20	1–4, 3–2, 4–5, 7–5, 7–13

	Paragraph	Page
Correlation factor data requirement	3–6*a*, 4–9*d*(2)	3–2, 4–5
Determination	1–8*b*, 3–5, 4–11*a*	1–4, 3–2, 4–6
Explanation	1–8*a*, 7–20	1–4, 7–13
Factors affecting	1–8*b*, 3–5*a*	1–4, 3–2
Ground survey. (*See* Radiological survey.)		
Ground zero:		
General	2–8*g*	2–7
Estimation of location	2–8*b*, 2–9	2–4, 2–7
Height of burst	2–8*f*	2–6
H-hour determination	7–13*d*, 7–19	7–8, 7–13
Illumination time:		
General	2–8*i*	2–7
Use in estimation of yield	2–11	2–10
Induced radiation:		
Area:		
Boundary:		
Shape	5–12	5–14
Size	1–5*b*, 5–12	1–3, 5–14
Crossing:		
Modes of crossing	5–12	5–14
Obstacles	1–5*b*	1–3
Problems	5–15	5–20
Routes	5–12	5–14
Description	1–5*b*	1–3
Marking	5–17	5–21
Monitoring	5–12	5–14
Occupancy	1–5*b*, 5–12	1–3, 5–14
Operations	5–12	5–14
Characteristics	5–11	5–14
Decay:		
Calculations	5–13	5–15
Variable	5–13*a*	5–15
Decontamination	5–11	5–14
Detected	7–8*b*	7–4
Dose calculations	5–14, 5–15	5–19, 5–20
Dose-rate calculations	5–13*a*, 5–14	5–15, 5–19
Evaluated	7–8*c*	7–4
Explanation of Term	1–3*a*(2)	1–1
Location of ground zero	5–11	5–14
Nature	5–10	5–14
Operationally significant	1–5*b*	1–3
Perimeter	7–8	7–4
Shielding. (*See* Shielding.)		
Soil	5–10, 5–13	5–14, 5–15
Tactical impact	7–2*a*	7–1
Intelligence, radiological:		
Collection effort	1–11	1–7
Dissemination	1–9*a*, 7–3*b*, 7–34	1–4, 7–1, 7–22
Forms	1–10	1–7
Types:		
Contamination overlay	1–9*b*	1–4
Fallout prediction	1–9*a*	1–4
Use	1–12	1–8
Kaufman equation	5–13*a*, 7–18*a*, 7–21	5–15, 7–9, 7–16
Large-area contamination	1–5*a*, 7–2	1–3, 7–1

	Paragraph	Page
Logarithms	7–18*e*	7–12
Marking of contaminated areas	5–17—5–20	5–21
Maximum dose rate	5–6, 5–12*c*, 5–15*b*	5–7, 5–15, 5–20
Militarily significant contamination	1–3*a*(3), 4–8*a*, 7–8*c*	1–2, 4–2, 7–4
Monitoring:		
Area	3–1, 3–3	3–1
Correlation factor. (*See* Correlation factor.)		
Correlation factor data. (*See* Correlation factor data.)		
Food	3–18	3–7
For acceptable levels of contamination	3–16*b*	3–7
Materiel	3–20	3–8
Organization:		
Equipment	3–1, 3–2, 3–8, app B	3–1, 3–3 B–1
Personnel	3–1, 3–2, 3–7	3–1, 3–3
Personnel	3–17	3–7
Purpose	3–10	3–4
Recording data	3–15	3–5
Report format	3–11, app C	3–4, C–1
Reporting data	3–11—3–13	3–4
Reports:		
Automatic	3–12	3–4
Communications	3–14	3–5
Other	3–13	3–5
Special	7–13	7–7
Use	3–2*b*	3–1
Responsibilities	1–11, 3–7	1–7, 3–3
Survey meter. (*See* Survey meter.)		
Techniques	3–5	3–2
Training. (*See* Training.)		
Types:		
Continuous	3–4*b*	3–1
Periodic	3–4*a*	3–1
Value	3–2	3–1
Water	3–19	3–8
Neutron-induced radiation. (*See* Induced radiation.)		
Nomograms:		
Correction factor for nonstandard decay (HIGH n)	5–9*b*	5–13
Correction factor for nonstandard decay (LOW n)	5–9*b*	5–13
Residual radiation decay (fallout)	5–2*b*	5–1
Residual radiation decay (induced radiation)	5–13*b*	5–17
Total dose (fallout)	5–3*b*	5–3
Total dose (induced radiation)	5–14*a*	5–19
Yield estimation flash-to-bang time or distance to ground zero versus nuclear burst cloud width at 5 minutes after detonation)	2–10*b*	2–7
Yield estimation (flash-to-bang time versus stabilized cloud-top angle or stabilized cloud-bottom angle)	2–10*d*	2–10
Normalized dose rate. (*See* CBRE, Operations, Calculations; Fallout, Calculations.)		
Normalizing factors. (*See* CBRE, Operations, Calculations.)		
Nuclear burst:		
Flash-to-bang time	2–8*b*	2–4
Ground zero	2–8*g*, 2–9	2–7
Height of burst	2–8*f*	2–6

	Paragraph	Page
H-hour. (*See* CBRE, Operations, Calculations.)		
Parameters	2–10	2–7
Reports. (*See* Nuclear burst report.)		
Yield estimation:		
Illumination	2–11	2–10
Nuclear yield calculator	2–12	2–11
Nuclear burst cloud:		
Angles	2–8*e*	2–6
Appearance	2–8	2–4
Development	2–8	2–4
Methods for estimating parameters:		
Angle-measuring equipment	2–4*a*	2–2
Angles	2–8*e*	2–6
Azimuths	2–8*c*	2–6
Cloud width	2–8*d*	2–6
Distance from observer	2–8*b*	2–4
Ground zero	2–8*b*, 2–9	2–4, 2–7
Illumination time	2–11	2–10
Training	2–13	2–11
Yield estimations	2–10, 2–11	2–7, 2–10
Report data. (*See* Nuclear burst report.)		
Stabilized	2–8*a*	2–4
Width	2–8*d*, 2–10*b*	2–6, 2–7
Nuclear burst data (*also see* Nuclear burst cloud):		
Requirement	2–1, 2–2*a*, 2–7*a*	2–1 2–4
Sequence for obtaining	2–5	2–3
Special information	2–7*b*	2–4
Use	2–1, 2–2*a*, 2–7*a*	2–1 2–4
Nuclear burst report:		
Communications	2–2*b*, 2–4, app B	2–1, 2–2, B–1
Format. (*See* Nuclear burst report format.)		
Instructions:		
Collecting data	2–5	2–3
Transmission	2–2*c*	2–2
Requirement	2–2*a*, 2–7	2–1, 2–4
Responsibility	2–4	2–2
Sample	2–3	2–2
Use	2–7	2–4
Nuclear burst report format	2–2, app C	2–1, C–1
Operation exposure guide	1–3*a*(4), 4–4, 4–22*e*, 6–3, 6–4*c*	1–2, 4–1, 4–12, 6–1, 6–3
Overall correction factor	3–15, 7–22	3–5, 7–16
Overlapping fallout	5–8*b*(4), 7–9*a*(5), app G	5–10, 7–5, G–1
Peak dose rate	3–12*b*	3–5
Plotter, fallout contamination. (*See* Fallout.)		
Plotting:		
Contour lines	7–28—7–30	7–19
Data:		
Aerial survey	7–26*b*, 7–27	7–18
Ground dose rate	7–25	7–18
Ground survey	7–26*a*	7–18
Monitoring	7–18	7–9
Normalizing factor	7–21*c*	7–16

	Paragraph	Page
Decay rate	7–18	7–9
H-hour	7–19	7–13
Wind vector plot	7–5*b*	7–3
Protection. (*See* Shielding; Protective measures.)		
Protective measures:		
Against:		
Fallout	1–5*a*, 5–6*b*, 5–17	1–3, 5–7, 5–21
Illumination	2–8*a*, 2–11	2–4, 2–10
Induced radiation	1–5*b*, 5–12, 5–17	1–3, 5–14, 5–21
Nuclear blast	2–8*b*	2–4
Training	2–13, 3–7	2–11, 3–3
Rad	1–3*a*(5)	1–2
Radiac instruments. (*See* Survey meter; Radiacmeter.)		
Radiacmeter (*also see* Survey meter):		
Measuring dose (dosimeter)	3–8, 4–26*b*, app B	3–3, 4–13, B–1
Measuring dose rate	3–8*a*, 3–16*a*, 4–26*a*	3–3, 3–7, 4–13
Monitoring personnel, food, water, and materiel	3–16—3–20	3–7
Recharging dosimeters	6–8	6–6
Training. (*See* Training.)		
Radiation. (*See* Fallout; Induced radiation.)		
Radiation exposure guidance:		
Categories of exposure	6–4	6–1
Degree-of-risk criteria	6–4*b*	6–2
Determination of category	6–7	6–5
Effect of use on operations	6–3	6–1
Individual dosimetry	6–12	6–7
Operation exposure guide (*See* Operation exposure guide.)		
Purpose	6–2	6–1
Records	6–5	6–3
Tactical dosimetry	6–6	6–4
Use of tables	6–4*a*, 6–6, 6–7, 6–11	6–1, 6–4, 6–5, 6–6
Radiation safety	3–5*a*, 3–7*b*, 4–4	3–2, 3–3, 4–1
Radiological agents	1–3*a*(8), 5–8*b*, 7–2*a*	1–2, 5–10, 7–1
Radiological data sheet	3–8*c*, 3–15, 4–13, 4–22	3–3,3–5,4–7, 4–12
Radiological monitoring. (*See* Monitoring.)		
Radiological survey:		
Aerial:		
Advantages	4–7	4–2
Aircraft:		
Capability	4–12	4–7
Types	4–10	4–6
Air-ground correlation factor data	4–11	4–6
Air-ground correlation factors	4–10, 4–11	4–6
Communications	4–13*b*, 4–26, app B	4–7, 4–13, B–1
Control methods	4–1, 4–3, app B	4–1, B–1
Control parties	4–1, 4–25*b*	4–1, 4–12
Detailed	1–10*d*, 4–9	1–7, 4–4
Disadvantages	4–7	4–2
Planning	4–9*a*, 7–12	4–5, 7–6
Recording data	4–13*a*, 4–22*a*	4–7, 4–12
Reliability of data	4–15	4–9
Reporting data	4–13*b*, 4–22*b*	4–7, 4–12
Simplified	1–10*c*, 4–8	1–7, 4–2

	Paragraph	Page
Survey meter. (*See* Survey meter.)		
Survey parties:		
Briefing	4–4*a*, 4–14, 7–15	4–1, 4–7, 7–8
Equipment	4–12, 4–24, 4–26	4–7, 4–12, 4–13
Guidance	4–14	4–7
Personnel	4–24, 4–25*b*	4–12
Training	3–7, 4–25*d*	3–3, 4–13
Techniques:		
Course leg	4–9*b*, *c*	4–5
Point	4–9*b*, *d*	4–5
Route	4–9*b*	4–5
Control methods:		
Centralized	4–3, 7–12, app B	4–1, 7–6, B–1
Decentralized	4–3, 7–12, 7–14, app B	4–1, 7–6, 7–8, B–1
Coordination	4–6, 7–15, app B	4–2, 7–8, B–1
Ground:		
Advantages	4–16	4–9
Communications	4–22, app B	4–12, B–1
Control parties	4–25*c*	4–13
Correlation factor data	4–20, 4–21	4–10
Disadvantages	4–16	4–9
Foot surveys	4–16	4–9
Operation exposure guide	4–4, 4–22*e*	4–1, 4–12
Planning	4–19, 7–12	4–10, 7–6
Recording data	3–15, 4–22*a*	3–5, 4–12
Reporting data	4–22*b*, app B	4–12, B–1
Requirement	7–12	7–6
Survey meter. (*See* Survey meter.)		
Survey parties:		
Briefing	4–4*a*, 4–18, 7–15	4–1, 4–10, 7–8
Capability	4–23	4–12
Equipment	4–16, 4–26	4–9, 4–13
Guidance	4–18	4–10
Personnel	4–1, 4–16, 4–25*a*	4–1, 4–9, 4–12
Training	3–7, 4–25*d*	3–3, 4–13
Techniques	4–17	4–9
Turn-back dose	4–4, 4–22*e*, 6–3*e*	4–1, 4–12, 6–1
Turn-back dose rate	4–4, 4–22*e*, 6–3*e*,	4–1, 4–12, 6–1
Vehicles	4–16, 4–23	4–9, 4–12
Planning	4–19, 7–12	4–10, 7–6
Value	4–2	4–1
Reports	app B, app C	B–1, C–1
Residual radiation. (*See* Fallout; Induced radiation.)		
Residual radiation decay. (*See* CBRE, Operations, Calculations; Decay; Fallout.)		
Shelters. (*See* Shielding; Survey meter, Location.)		
Shielding:		
Correlation factor data	3–6, 4–11	3–2, 4–6
Ground dose rate	1–8, 3–6, 4–11, 4–17*a*, 7–20	1–4, 3–2, 4–6, 4–9, 7–13
Location of survey meter. (*See* Survey meter, Location.)		
Of radiation by:		
Aircraft	1–8*b*, 4–7	1–4, 4–2
Shelters	1–8*b*, 3–5*b*	1–4, 3–2
Vehicles	1–8*b*, 4–16, 4–23	1–4, 4–9, 4–12

	Paragraph	Page
Protection of personnel. (*See* Protective measures.)		
Transmission factor. (*See* Transmission factor.)		
Transmission factor data. (*See* Transmission factor data.)		
Shock wave	2–5*a*, 2–8*b*	2–3, 2–4
Simplified fallout predictor	app B	B–1
Soil, radioactivity	5–10	5–14
Soil types	5–13	5–15
Survey meter:		
Checks	3–9	3–3
Definition	3–1	3–1
Location:		
For monitoring (routine)	3–4, 3–5*a*	3–1, 3–2
For obtaining correlation factor data:		
Aircraft	4–10, 4–11	4–6
Shelters	3–5*b*, 3–6	3–2
Vehicles	3–5*b*, 4–20, 4–21	3–2, 4–10
Personnel	1–11*a*	1–7
Training. (*See* Training.)		
Use in monitoring of areas	3–1	3–1
Use in survey of areas	4–20	4–10
Survey, radiological. (*See* Radiological survey.)		
Tables:		
4–1. Location of survey meter during aerial survey		4–6
4–2. Air-ground correlation factors		4–7
6–1. Dose criteria for placing units in radiation status categories		6–2
6–2. Nuclear radiation degree-of-risk exposure criteria		6–3
6–3. Radiation dose status chart, month 6		6–4
6–4. Determination of company/battalion radiation status		6–4
6–5. Radiation dose status chart, month 10		6–7
7–1. Radiological survey party briefing order		7–8
7–2. Normalizing factors (correction to H + 1)		7–17
Terms and symbols	1–3*a*, 1–3*b*, app F	1–3, F–1
Time of arrival of fallout	7–17	7–9
Time of burst. (*See* H-hour determination.)		
Time of completion of fallout. (*See* CBRE, Operations, Calculations.)		
Time of entry (*also see* Fallout area)	1–3*a*(1)	1–1
Time of exit. (*See* Fallout area.)		
Time of stay (*also see* Fallout area; Induced radiation)	1–3*a*(9)	1–2
Total dose. (*See* CBRE, Operations, Calculations; Fallout, Calculations; Induced radiation.)		
Training:		
Control party	1–11*b*, 4–25*d*	1–7, 4–13
Cross-training of CBRE personnel	7–3*d*	7–2
Individual	1–11*a*, 2–13*a*, 3–7*a*	1–7, 2–11, 3–3
Methods of estimating nuclear yield	1–11*a*, 2–13*b*, app B	1–7, 2–11, B–1
Monitor	1–11*a*, 3–7, app B	1–7, 3–3, B–1
Protective measures	2–13, 3–7*b*	2–11, 3–3
Radiacmeter	3–7	3–3
Survey party	1–11*a*, 4–25*d*	1–7, 4–13
Unit	2–13*b*, 3–7*b*	2–11, 3–3
Transmission factor:		
Determination	5–5*b*	5–7
Explanation	1–8*c*, 5–5	1–4, 5–5
For induced radiation	5–5, 5–16	5–5, 5–21
Published	5–5, 5–7*b*	5–5, 5–10
Requirement	5–5*b*	5–6

	Paragraph	Page
Use	1–8*c*, 5–5*c*, 5–6*f*, 5–7*b*	1–4, 5–7, 5–8, 5–10
Transmission factor data	3–5*a*, 5–5	3–2, 5–5
Upper air wind data	1–10*a*, 2–1	1–7, 2–1
Water	3–19	3–8
Weather, effect on:		
Fallout	1–5*a*, 2–1	1–3, 2–1
Induced radiation	5–11	5–14
Nuclear burst observations	2–5	2–3
Radiological survey	4–16, 7–12*b*(4)	4–9, 7–7
Wind:		
Effect on:		
Fallout	1–5, 2–1	1–3, 2–1
Fallout direction from ground zero	1–5*a*	1–3
Fallout prediction. (*See* Upper air wind data.)		
Vector plot	7–5*b*	7–3

Yield estimation. (*See* Nuclear burst; Flash-to-bang time; Calculator.)

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